SCIENCE

2 JULY 1954

VOLUME 120 NUMBER 3105

Contents

Professional and Scientific Personnel in the U.S.S.R.: *Nicholas DeWitt* 1

Natural Radiocarbon Measurements by Acetylene Counting: *Hans E. Suess* 5

Metallo-Flavoproteins and Electron Transport: *H. R. Mahler* and *D. E. Green* 7

Attitudes of College Seniors toward Federal and Industrial Employment: *Lowell H. Hattery* and *Charles M. Hersh* 12

News and Notes

Work of the UNESCO Advisory Committee on Arid Zone Research; and Regular Departments 15

Book Reviews

Microwave Theory and Techniques; Australian and New Zealand Botany; Protozoaires; Renal Function; British Veterinary Codex 1953; Microwave Lenses; Hydrocarbons from Petroleum; and New Books 25

Miscellaneous Publications 30

Technical Papers

Mast Cells in Human Atherosclerosis: *A Cairns* and *P. Constantinides* 31

Sulfide Inhibition of Catalase: *Roland F. Beers, Jr.*, and *Irwin W. Sizer* 32

The Role of Magnesium in Photosynthesis: *Leonard S. Levitt* 33

Desoxyribose Nucleic Acid in the Symbiotic Microorganisms of the Cockroach, *Blattella germanica*: *M. T. M. Rizki* 35

A Fungus Disease in Clam and Oyster Larvae: *H. C. Davis* et al. 36

Communications

Fatty Acid Absorption and Chylomicrons: Discussions by *A. C. Frazer*; *H. Singer, J. Sporn* and *H. Necheles* 39

Effect of Elemental Sulfur in the Diet on Load-Extension Hysteresis in Single Wool Fibers: *G. L. Clark* and *V. E. Buhrke* 40

Trends in Supply of Scientists and Engineers in the United States 5A

Meetings & Conferences 8A

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

how Lab-aid's

45% greater capacity

cuts filing costs . . . saves floor space

a single Lab-aid cabinet holds up to 6500 (average) 1" microslides.

other type files need up to this much more space to hold as many.

How can a "Lab-aid" filing cabinet pack so much in so little space?

Look at one to see. You'll find no thick bulkheads between drawers, no space-consuming buttresses, no bulky tracking guides.

Every cubic inch inside is a hard-working "storage inch." The patented "Lab-aid" construction gets fourteen full-length drawers in a cabinet only 19" square. Yet, close-set as they are, every drawer slides straight and true, easily, smoothly, without binding.

Drawers are freely interchangeable, too. Use 1", 2", and 4" capacity full-length drawers in the same unit, in any arrangement you want, for microslides, transparencies, lantern slides, cards, etc. And use *any* of them *anytime* for *spaced* filing instantly. Lift out the separator, and you clear the drawers for close-packed storage.

Other units in the "Lab-aid" line provide for flat-filing microslides . . . for filing paraffin blocks, for "frame-spread" transparency filing. All are staunchly built of heavy gauge steel, strongly welded throughout. All have the same basic 19" square dimension, so they stack rigidly to any convenient height.

Write for the catalog describing these uniquely efficient "Lab-aid" filing cabinets..

. . . because every inch is a *filing* inch

TECHNICON Lab-aid

laboratory filing equipment

THE TECHNICON COMPANY
215 East 149 St., New York 51, N. Y.

These same Cabinets are manufactured by our French Corporation:
COMPAGNIE TECHNICON ● 7 rue Georges Ville ● Paris

cenco brings you another

NEW PRODUCT

CENCOIL-B

Here is a highly purified, di-2-ethyl hexylphthalate, which when used in a metal three-stage, non-fractionating diffusion pump, produces a vacuum of the order of 5×10^{-5} mm (Hg) or better at 25° C without the use of a liquid air or charcoal trap. This oil is stable and permits operation at relatively high forepressures with low heat input. It is especially suitable for use with the new Cenco Supervac Pump OD-25 or any other fractionating or non-fractionating oil diffusion pump which you may have.

100 Gram bottle,
$4.25

500 Gram bottle,
$17.00

Order today

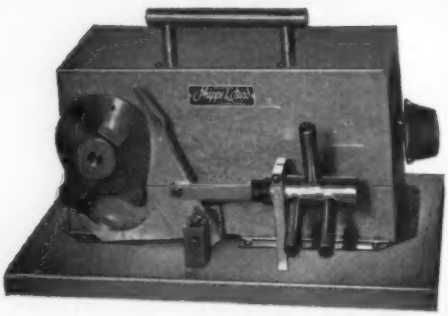
Our 14 branch offices and warehouses assure prompt service and shipment

cenco
The most complete line of scientific instruments and laboratory supplies in the world
R.S.C.

CENTRAL SCIENTIFIC COMPANY
MAIN OFFICE — PLANT — CENCO INTERNATIONAL CIA.
1718-M IRVING PARK ROAD • CHICAGO 13, ILLINOIS
BRANCHES AND OFFICES — CHICAGO NEWARK BOSTON WASHINGTON DETROIT SAN FRANCISCO SANTA CLARA LOS ANGELES
CENTRAL SCIENTIFIC CO. OF CANADA, LTD. (and Hendry Division)
TORONTO MONTREAL VANCOUVER OTTAWA
REFINERY SUPPLY COMPANY — TULSA HOUSTON

PHIPPS & BIRD

VARI-PHASE VALVE



This valve in conjunction with a source of compressed air is used to control artificial respiration.

Control of one knob facilitates respiration rates of 15 to 50 per minute. The inspiration to expiration time ratio may be set to any value between 1:4 to 4:1. By loosening one screw the valve may be removed for cleaning and sterilizing.

For operation on 115 volt 60 cycle only.

Cat. No. 71-216 *$125.00*

Phipps & Bird, Inc.

MANUFACTURERS AND DISTRIBUTORS OF SCIENTIFIC EQUIPMENT

6th & BYRD STREETS - RICHMOND, VA.

2385 RHODE ISLAND AVE., N. E.
WASHINGTON, D. C.

β GLUCURONIDASE

Available as a solution with an activity of approximately 700 Fishman units per ml.

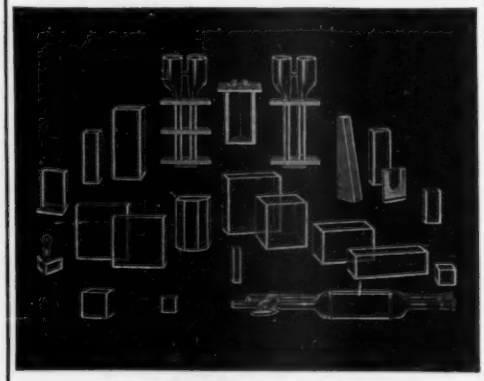
URICASE

Suitable for spectrophotometric uric acid assay

write for specifications

WORTHINGTON BIOCHEMICAL CORP.
Freehold, New Jersey

GLASS ABSORPTION CELLS made by KLETT



Makers of Complete Electrophoresus Apparatus

SCIENTIFIC APPARATUS

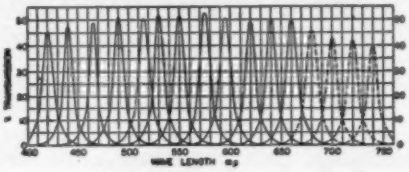
Klett-Summerson Photoelectric Colorimeters—Colorimeters — Nephelometers — Fluorimeters—Bio-Colorimeters — Comparators — Glass Standards—Klett Reagents.

Klett Manufacturing Co.
179 East 87 Street, New York, New York

G.A.B. Interference Filters

(Made in Switzerland)

for isolating narrow spectral bands



Spectral Range: 400-900 millimicrons
Spectral Width: 12-15 mμ, Transm.: 45-50%
Size: 2" x 2". Other sizes on order.

For

Flame Photometry and Color Densitometry
Microscopy and Photomicrography
Colorimetry and Fluorimetry

also in reflectometry, light scattering measurements, microcolorimetry, refractometry, polarimetry, and in all other fields requiring monochromatic light in the visible and near-infrared range.

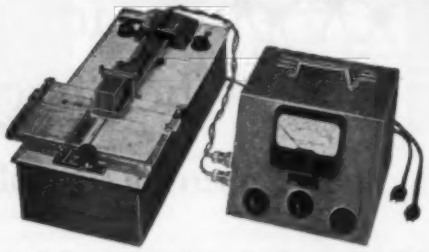
Write for Bulletin #180 to

PHOTOVOLT CORP.
95 Madison Ave. New York 16, N. Y.

PHOTOVOLT Densitometer

for

Partition Chromatography
and Paper Electrophoresis



A photoelectric precision instrument for the rapid and convenient evaluation of strips and sheets of filter paper in partition chromatography and paper electrophoresis

Write for Bulletin #800 to

PHOTOVOLT CORP.
95 Madison Ave. New York 16, N. Y.

Also: Colorimeters | pH Meters | Multiplier Photometers
Fluorimeters | Nephelometers | Interference Filters

RESEARCH BIOCHEMICALS
OF
HIGHEST POSSIBLE PURITY

FOR INVESTIGATIONAL USES

Typical Amino Acids
GAMMA AMINO BUTYRIC ACID
ASPARAGINE, D, DL, L
CANAVANINE SULPHATE
DL CITRULLINE
DL DIHYDROXYPHENYLALANINE
GLUTAMINE
HOMOCYSTEINE
HYDROXY-L-PROLINE
METHIONINE, D, DL, L
METHIONINE, SULFONE, SULFOXIDE
PHENYLALANINE, D, DL, L
SERINE, D, DL, L
THREONINE, D, DL, L
TRYPTOPHANE, D, DL, L
VALINE, D, DL, L

AMINO ACIDS
A complete selection of more than 100 Amino Acids

Pre-tested for rigid specification adherence to assure highest possible purity for exacting requirements of Biochemical Research.

WRITE FOR NEW CATALOG

Over 1200 Items

NBC
NUTRITIONAL BIOCHEMICALS
CORPORATION
21010 MILES AVENUE • CLEVELAND 28, OHIO

SCIENCE is published weekly by the AAAS, 1515 Massachusetts Ave., NW, Washington 5, D. C. Entered at the Lancaster, Pa., Post Office as second class matter under the act of March 3, 1879. Annual subscriptions: $7.50; foreign postage, outside the Pan-American Union, $1; Canadian postage, 50¢.

Books in Chemistry

by Flory, Robertson & Ingold

PRINCIPLES OF POLYMER CHEMISTRY

By Paul J. Flory, Cornell University

"The book presents an interpretation of early developments and sets forth essential definitions and elementary concepts. . . . No previous knowledge of polymers has been assumed."—*Isotopics*

1953. 688 pages, 146 figures, 43 tables. $8.50

ORGANIC CRYSTALS AND MOLECULES

Theory of X-Ray Structure Analysis with Applications to Organic Chemistry

By J. Monteath Robertson, University of Glasgow

"The reviewer enthusiastically recommends the book to anyone interested in learning either about modern methods of crystal structure analysis or about the results of such analysis in the field of organic compounds."—*Journal of Chemical Education*

1953. 351 pages, 132 illustrations. $5.00

STRUCTURE AND MECHANISM IN ORGANIC CHEMISTRY

By C. K. Ingold, University of London

"There can be no question that this is one of the few great books on organic chemistry. It is . . . a fascinating account of modern organic chemical theory. . . ."—*Journal of the American Chemical Society*

1953. 835 pages, 45 figures, 162 tables. $9.75

For complete information about these titles please write to

Cornell University Press

124 Roberts Place, Ithaca, New York

DIFCO

MICROBIOLOGICAL ASSAY of Amino Acids and Vitamins

Difco Media are available for the microbiological assay of

Leucine	Riboflavin
Isoleucine	Niacin
Methionine	Thiamine
Lysine	Pantothenic Acid
Arginine	Biotin
Cystine	Vitamin B_{12}
Tyrosine	Folic Acid
Phenylalanine	Pyridoxine
Tryptophane	Choline

Citrovorum Factor

Each medium is free from the essential growth requirement factor for which the medium is recommended. The addition of this factor in specified increasing concentrations elicits a growth response of the test organism which may be measured acidimetrically or turbidimetrically. Appropriate media for carrying cultures in stock, and preparation of inocula for each test are available.

Complete details of media for Microbiological Assay available upon request.

Difco Laboratories
Detroit 1, Michigan

VOLUMETRIC SPIRAL FRACTIONATOR

GME

714 MARKET PLACE
MADISON 3 WIS.

19 INCH SQUARE
8 CHANNEL EEG
(Polygraph)

Original Circular Warburg

AAAS EDITORIAL BOARD

Duane Roller
Editor

Charlotte V. Meeting
Assistant Editor

Mark H. Adams
William R. Amberson
Wallace R. Brode
Bentley Glass
Karl Lark-Horovitz
Edwin M. Lerner
Walter J. Nickerson
William L. Straus, Jr.

Advertising Representative: F. A. Moulton

Trends in Supply of Scientists and Engineers in the United States

THE number of scientists and engineers in the United States is increasing, but optimism in this respect is tempered by certain modifying trends.

The over-all number of young people attending institutions of higher learning is growing. In 1930, college and university enrollments were 12 percent of the population in the age group 18 to 21 yr; in 1940, they increased to 16 percent; and in 1953, after the G.I. bulge, they were 21 percent. In addition, higher birth rates will also result in greater numbers of young people going to college. In 1949 and 1953, there were about 2.5 million young people attending college. By 1960, an estimated 2.7 million may be enrolled, and if present trends continue the number may increase to 3.4 million by 1965. However, full mobilization would severely reduce these estimates.

High-school grades and standardized test scores indicate that careers in science are attracting many of our most competent college students. According to studies by Dael Wolfle, college students in the physical sciences average near the top in performance, both in high-school academic work and on intelligence tests, and biology students hold their own with students in all fields.

The proportion of professional, technical, and kindred persons in the labor force, as reported by the Census Bureau, almost doubled between 1910 and 1950. Numerically, the increase was even more spectacular—from 1.6 million to 5.1 million. The increase in the numbers of scientists and engineers has also been rapid. Between 1930 and 1953, the number of scientists increased from about 46,000 to about 200,000, and the number of engineers from approximately 215,000 to about 500,000.

Despite these increases, however, slightly less than 0.5 percent of our total population are scientists and engineers. One of the grave problems facing the nation, therefore, is how to use these crucial skills and, at the same time, preserve the freedom essential to the advancement of knowledge.

More important than the statistics on the number of scientists, however, is the quality of their training. Are the competent young people finishing high school adequately trained, and are the science students finishing our colleges and universities capable of creative research? Probably only time will tell, but the number of able young people in a particular field will certainly influence its direction and growth.

On the other side of the picture is the high number of promising young people who do not go on to higher learning. Although almost all students with intelligence higher than that of the average college graduate finish high school, nearly half of them do not enter institutions of higher education, and an appreciable number of those who enter do not finish. The increasing numbers of students going into science and engineering is not being matched by a proportionate increase in the number of qualified teachers. Teacher salary scales are below those for comparably trained people in industry and government, and sometimes below the scale for skilled labor. Increasing teaching loads leave many of our teachers little time for their own research and intellectual refreshment.

Comparing our own efforts with those of other nations, we note that apparently there are in the U.S.S.R. more than 400,000 engineers and 150,000 scientists, compared with 500,000 and 200,000 in the United States. Of greater moment, however, is the greater emphasis they put on training in science and technology. Their rate of production of well-trained scientists and engineers seems to be higher than ours. Soviet scientists are believed to be competent, and there is strong evidence that they are improving the quality of their specialized training. Their emphasis on technological training is at the expense of the humanities and the liberal arts, however, and we must guard against these dangers of overspecialization.

The complex problems facing the United States today cannot be solved by technical skills alone, important as these are, and it behooves us to give the best and broadest training to our young scientists and engineers.

HARRY C. KELLY

National Science Foundation
Washington 25, D.C.

SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at Business Press, Lancaster, Pa. Entered at the Lancaster, Pa., Post Office as second class matter under the Act of March 3, 1879.

All correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D. C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors.

Change of address: The notification should reach us four weeks in advance. If possible, please furnish an address stencil label from a recent issue. Be sure to give both old and new addresses, including postal zone numbers, if any.

Annual subscriptions: $7.50; foreign postage, outside the Pan-American Union, $1.00; Canadian postage, 50¢. Single copies 25¢. Special rates to members of the AAAS.

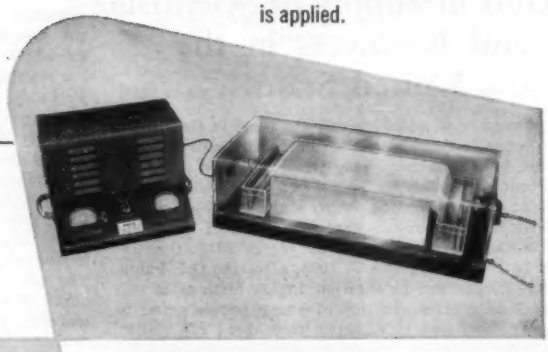
SCIENCE is indexed in the *Reader's Guide to Periodical Literature.*

The AAAS also publishes THE SCIENTIFIC MONTHLY. Subscription and advertising rates will be furnished on request.

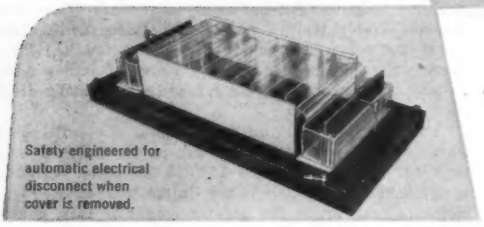
THE RECO
PAPER ELECTROPHORESIS
APPARATUS

...for separations of organic or inorganic compounds having electro-migratory characteristics when electric potential is applied.

Applicable for clinical estimation of human blood protein constituents



PRICE: RECO Model E-800-2 Paper Electrophoresis Apparatus, consisting of Power Unit and Migration Chamber, complete, **$290.00**
(Price does not include Automatic Timer)



Safety engineered for automatic electrical disconnect when cover is removed.

RECO Paper Chromatographic Equipment also available: Chromatocabs (for two-dimensional separations)...Drying Ovens...Electric Desalter (for removal of inorganic salts from organic and amino acids)...Racks, stainless steel and Pyrex (for one-dimensional separations)...Pyrex Chromatography Jars (with specially ground top edges)...Pyrex Solvent Troughs (or complete assemblies)...Densitometers...Ultra Violet Lamps...Disc Chambers...Stainless Steel Clips...Pyrex Indicator Sprayers ...Micro Pipets. **Write for General Catalog.**

Foreign inquiries solicited. Delivered prices quoted on request.

SPECIAL FEATURES

- **Water Cooled Surface** for Paper or Starch...The platform surface, on which buffer saturated filter paper or starch is placed, is cooled by circulating water (see illustration) to reduce evaporation and minimize change in buffer solution during operation, thus permitting use of high voltages.
- **Power Unit** supplies 0-720 volts at 200 miliamps continuously variable, with 3½-inch volt-meter and 3½-inch double scale miliamp meter reading 0-20 and 0-200 miliamps for accurate current measurements. Direct current measurements. Direct current ripple is reduced by means of a choke-capacitor filter. Multiple power outlets available at nominal extra cost. For 115 volts AC.
- **Anti-diffusion plates** in electrode troughs reduce any changes in electrolyte at the paper due to electrolysis.
- **Platform surface** is quickly adaptable for either paper or starch paste by means of end gates.
- **Electrode vessels** easily dismounted for cleaning.
- **Automatic timer** for use in conjunction with power supply (at additional cost).

Write for Brochure SS-10

MANUFACTURED BY

RESEARCH EQUIPMENT *Corporation*

1135 THIRD STREET • OAKLAND 20, CALIFORNIA • TWinoaks 3-0556

CABINETS for Continuous Vertical Curtain Electrophoresis Apparatus will be offered shortly. If interested, request Brochure S-12 to be mailed when issued.

Professional and Scientific Personnel in the U.S.S.R.

Nicholas DeWitt

Russian Research Center, Harvard University, Cambridge, Massachusetts

SINCE the late thirties, under a veil of growing secrecy, Soviet authorities have become increasingly reluctant to publish detailed information concerning the supply of specialists in the U.S.S.R. In view of this and of the growing desire among Western scholars and the public in general for clarification of the Soviet professional and scientific manpower problems, a study entitled *The Soviet Professional Labor Force, 1928–53* was undertaken, some of the summary findings of which are presented here (*1*).

As early as 1930 and especially after the 1933 decree concerning placement of trained personnel, Soviet authorities established the legal practice of the involuntary placement of professionals and semiprofessionals within occupational fields that coincided with the formal specialized training completed by them in academic institutions. This practice was greatly intensified during the immediate prewar period (1938–40) and solidified by labor legislation acts further restricting occupational mobility. At the same time, the ranks of professionals began to be filled predominantly by increasing numbers of graduates from academic establishments.

These trends continued without modification in the postwar period, and it is possible to argue that today in the Soviet Union the individual's professional occupation, such as engineer, medical doctor, veterinarian, and so forth, is determined primarily by the level of formal education and by the narrow field of specialization during this training. Thus, it appears justifiable to speak of the Soviet professional labor force as consisting predominantly of trained specialists with higher education and of the Soviet semiprofessional labor force as being composed, to a large extent, of persons with secondary specialized education and occupations determined by the respective specialization in the course of training.

These assumptions, verified in fact for the professionals in the course of the research, permit the use of available educational statistics in order to ascertain the size and occupational composition of the Soviet professional labor force, or at least, to be more precise, the dominant component within it. This, of course, does not preclude the fact that through some extra-legal actions or some informally acquired practical skills, both horizontal and vertical occupational mobility can and still does take place—only, however, to a limited extent and with ever-increasing restrictions.

At the end of 1953, the total number of workers and employees in the U.S.S.R. (excluding collective farm labor force, the military personnel, forced labor, and handicraftsmen) was 44.8 million persons (*2*), which constitutes a 42-percent increase over the 31.5 million at the end of 1940 (*3*). At the end of 1953, the number of specialists with completed secondary and higher professional and technical education, which, except for a few agricultural specialists, represents part of this labor force, was 5.94 million, which constitutes an increase of 138 percent over the 2.5 million in 1940 (*4*). It appears, therefore, that, although both the labor force itself and trained specialized personnel as a part of it experienced growth at a much slower rate than in the prewar decade (between 1930 and 1940 the labor force roughly doubled and the number of specialists increased about fivefold), the increase of trained professional and technical personnel continued at a considerably greater rate than the labor force itself, thus contributing substantially to the qualitative improvement of the latter.

In 1940, out of the total 2.5 million specialists employed in the national economy of the U.S.S.R. (that is, excluding military establishments), there were about 850,000 professionals with completed higher education and about 1,650,000 semiprofessionals with completed secondary specialized education. By the end of 1952, the number of specialists in these categories was estimated as 1,785,000 and 3,715,000, respectively (*5*). During 1953 an increment of about 200,000 and 240,000, respectively, took place.

However, at the same time a marked change appeared in the occupational distribution of professionals with completed higher education. Table 1 shows the distribution by type of occupational training at the end of 1940 and 1952.

Furthermore, it appears that during the last 12 yr the number of engineering and agricultural specialists increased by only a modest 65 percent and socioeconomic professionals by some 75 percent, but the medical and educational professionals increased by the large percentages of 148 and 164, respectively. This indeed represents a sharp reversal of a trend that existed in the prewar decade, when the number of trained engineers increased roughly sevenfold (from 41,000 in 1930 to 283,000 in 1940), while the entire professional labor force roughly tripled. This development is explainable not in terms of equalization of supply and demand for engineers and agricultural specialists, since training in these fields has not de-

Table 1. Distribution by training of Soviet professionals with completed higher education.

Occupational training	End of 1940		End of 1952	
	(Thousands)	(Percent)	(Thousands)	(Percent)
Engineers of all types in construction, manufacturing, transportation, and communication	283.5	33.5	467.0	26.2
Agricultural specialists (in agronomy, veterinary medicine, land conservation, electrification and mechanization of agriculture, forestry)	97.3	11.4	161.0	9.0
Socioeconomic professionals (in economics, trade, accounting, banking, planning, statistics, jurisprudence, social and communal service)	61.7	7.3	109.0	6.1
Educational professionals (teachers and professors of all ranks, art and music performers and instructors)	284.1	33.5	748.0	41.9
Medical professionals (in therapeutics, preventive medicine, dentistry, pharmacy, athletic coaches and physical culture)	121.6	14.3	300.0	16.8
Total	848.2	100.0	1,785.0	100.0

clined in recent years as compared with the prewar period, but in terms of two expediencies that prevailed in the recent period.

On the one hand, the demand for medical professionals increased enormously during the war, and apparently the training of medical personnel was continued at a high level in the postwar period. On the other hand, the postwar policy of expanding upper grade enrollment in secondary schools created a large demand for teachers with higher education. As a result, by the end of 1950 the number of teachers with completed higher education was about 610,000, or 26 percent of the total 1,600,000 teachers employed. This also represents a substantial qualitative improvement over the 7 percent of teachers with completed higher education employed in 1939.

The substantial gain in the size of the trained professional labor force, which about doubled between 1940 and 1952, appeared primarily as a result of the ability of the Soviet higher educational system to turn out graduates. It might be true, however, that to some extent it was also caused by the preferential treatment of professionals through deferments and evacuation during the course of the war, which helped somewhat to reduce war losses. On the basis of the estimates made, it is possible to assume that hypothetical war losses (1941–45) owing to excess civilian deaths and male military deaths during the war among Soviet trained professionals were about 8 percent. These losses occurred among trained professionals, in addition to the average annual losses resulting from natural causes (retirement, death, and so forth) and political causes (persecution and firings), which, if the war had not taken place, would have been (as they actually were in the prewar decade) slightly more than 2 percent (*6*).

Furthermore, it was verified that, while in 1940 there were about 32 percent women professionals, by the end of 1952 the proportion of women had increased to about 50 percent, primarily because of the large increases of medical and educational professionals, where the relative share of women was already in 1940 about 60 and 40 percent, respectively, as compared with 20 percent in engineering in that year.

In 1953 the training of professionals was conducted in about 860 higher educational establishments, as compared with 750 in 1940. In addition, in 1953 there were about 40 higher educational establishments offering correspondence courses exclusively. The total enrollment in higher educational establishments in 1952–53 was 942,000, as compared with 620,000 in 1940. In addition, in 1952–53 there were about 500,000 correspondence students, more than 70 percent of whom were receiving training in the field of education (primarily teachers for primary schools). In 1953–54 the total enrollment (including correspondence students) increased by 120,000, for a total of 1,562,000.

The distribution of annual graduations from higher educational establishments in two selected years, which reveal recent trends in training, is shown in Table 2. Without taking into account graduations through correspondence training (primarily teachers), it appears that, although a proportional decline in annual graduations of engineers occurred, in absolute terms the training of Soviet engineers (with 5½ yr of training, three of which are devoted to narrow specialization) continued at the same high numerical rates as in the prewar period and was considerably higher than that in the United States in recent years. Furthermore, out

Table 2. Distribution by field of graduations from Soviet higher educational establishments.

Field	1940		1952	
	(Thousands)	(Percent)	(Thousands)	(Percent)
Engineering	29.3	28.6	30.0	16.7
Agricultural	10.1	9.9	15.0	8.3
Socioeconomic	4.8	4.7	15.0	8.3
Educational	40.6	39.8	88.0	48.9
Medical	17.4	17.0	32.0	17.8
Total	102.2	100.0	180.0	100.0
Correspondence	Negligible		41.0	

of 88,000 graduations in the field of education in 1952, 18,000 were graduated from Soviet universities, and roughly one-half of them (that is, about 9000) were pure and applied natural-sciences majors (also with 5½ yr of training).

The most recent information indicates that graduations from higher educational establishments in the summer of 1954 are expected to be about 230,000, which would represent an increase of about 30,000 over the preceding year. It is planned that acceptances in the fall of 1954 will be about 440,000. The steady increment of acceptances during the last few years has been maintained largely because of the spectacular increase in graduations from secondary schools. Although in the prewar period the shortage of secondary-school graduates presented a phenomenal handicap in the selection of students for higher education, it appears that the Soviet educational system at the present time has reached a turning point in its evolution. For the first time a substantial surplus of secondary-school graduates over the available admission vacancies in higher educational establishments can be definitely ascertained. The secondary schools of the Russian Republic (*RSFSR*) alone, which in the past few years represented about 60 to 65 percent of the U.S.S.R.'s total, both by upper grade enrollment and secondary-school graduations, are expected to graduate 470,000 this summer. All this implies that a better selection of students entering professional training in higher educational establishments and the further expansion of this type of training might be quite feasible (*6a*).

Statistical analysis reveals also that the graduation rate, not ascertainable for the immediate postwar years owing to irregularity in the flow of students whose courses were interrupted, apparently is leveling off (1948–53, 70 percent) to the prewar level of about 60 graduations per 100 acceptances. Apparently, then, the strict selection of students in higher educational establishments, which according to established norms stipulates only 48 graduations per 100 acceptances, is again being enforced, at least to some extent.

In the fall of 1951 the full-time teaching staffs of Soviet higher educational establishments were about 80,000, as compared with 51,000 in 1940 (*7*). The last census of teaching staffs of higher educational establishments, conducted on 1 Jan. 1947, and made public in 1950, revealed that in that year out of 67,200 full-time professors and teachers, roughly one-third were teaching in engineering colleges, that approximately only 8 percent were full professors and 22 percent were assistant professors. It was revealed at that time that between Jan. 1947 and the end of 1951 the full-time teaching staffs should increase by 17 percent, a figure that apparently was realized. Furthermore, it was contemplated that in the years after 1951 the average annual rate of growth should be about 6 percent.

Although official data are lacking on the basis of past accomplishments and sustained increases in enrollment, it appears that by the end of 1953 there were probably about 90,000 full-time teachers and professors in Soviet higher educational establishments. It was also revealed at that time that the least number of students per teaching member of faculty was in the fields of engineering and natural sciences, which suggests that students in these fields apparently still continue to receive more attention than students in other disciplines.

The same census also revealed that the mean age of a Soviet professor (professor) was about 54 yr, and the mean age of an assistant professor (dotsent) was about 46 yr. This implies, on one hand, that a large turnover in the leading professorial staffs can be anticipated in the near future, but, on the other, a marked conservatism in regard to appointments to academic ranks. Furthermore, it was revealed that 35 percent of university and college teaching staffs consisted of women and that, what is more surprising, after 30 yr of Soviet rule only 35 percent of all teachers in higher educational establishments were members of the Communist Party, and notably in the fields of engineering and the physical-mathematical sciences, where only 17 and 19 percent of professors, respectively, were Party members.

In 1952 the Soviet Union had 2900 research establishments, as compared with 1560 in 1940 (*8*). They employed in 1952 twice as many research scientists in all fields as in 1940, or about 68,000, a large proportion of whom (probably about one-third) were still engaged in applied and technical research. Thus, about 9 percent of Soviet professionals in all fields (1,785,000) were engaged either in teaching in higher educational establishments (about 90,000) or in scientific and technical research (about 68,000). A large proportion of academic rank holders, however, especially in the fields of engineering and applied and natural sciences, were simultaneously involved in some research activity as well.

In the postwar period, a substantial increase in advanced-degree training is observable. Enrollment in advanced-degree training, which consists primarily of research work, under the personal guidance of senior research and teaching personnel, in academic institutions and research establishments in 1952 totaled about 27,000, as compared with 12,400 in 1940 and an almost negligible number a decade earlier (800 in 1929). By the end of 1952, among all professionals and presumably predominantly among those 158,000 who are engaged either in research or by higher educational establishments, there were about 50,000 with advanced academic degrees, about 40,000 with "candidate" degrees, and 10,000 with "doctor" degrees. On the basis of advanced-degree-enrollment trends and awards of advanced degrees, it appears that 35 to 40 percent of all advanced-degree holders are in the field of technical and applied natural sciences, 5 to 7 percent in each of the fields of pure mathematics and physics, chemistry, medicine, philology, economics, and the rest spread by a fraction of 1 percent over various other fields.

Plans made public at the recent Party Congress proposed that by 1956 annual graduations from higher educational establishments should be about double those of 1950, or 330,000 to 370,000 annually. Acceptances in the field of engineering in 1950 were more

than 70,000, and thus it is possible to expect that by 1956 Soviet higher educational establishments will be graduating about 50 percent more engineers annually than in 1950, or somewhat more than 45,000. Furthermore, the number of scientists in all fields employed by research establishments should also double, or reach a level of about 120,000. In the period between 1950 and the end of 1955, it was planned that the award of advanced graduate degrees should also double, as compared with the period between 1946 and the end of 1950, during which about 13,500 advanced degrees were awarded. Recent rapid expansion of upper grade enrollment in secondary schools (in 1953–54 the upper grade 8–10 enrollment in Soviet secondary schools was 4.5 million as against the highest prewar figure of 1.8 million in 1939–40) provides a substantially sound foundation for even further expansion of higher education after 1956. The already existing high level of enrollment suggests that these ambitious plans might become a reality. This in turn would imply a considerable increase in the size of the trained professional labor force and a substantial gain in trained scientific manpower.

Although there have been some notable postwar shifts in the occupational distribution of Soviet professionals and substantial gains have been made in the fields of education and medicine, the high numerical rate of training of engineers has continued. Furthermore, in the postwar period notable gains have been made in advanced-degree training, where engineering and applied sciences have continued to predominate. All this permits no complacence on our part. Until recently, only the institutional and general framework of the Soviet educational and scientific effort have received any attention, while the long-neglected problem of training and qualitative performance of Soviet scientists and professionals in many fields of research and technology still remains unsolved and almost unexplored (*9*). The entire field still awaits thorough objective investigation by Western scholars; and, as quantitative findings concerning Soviet efforts tend to suggest, it is high time to undertake this task.

References and Notes

1. I am greatly indebted to the Russian Research Center of Harvard University for the financial assistance that made the study possible, to A. Inkeles for his guidance, and to D. B. Shimkin for his help in the initial stages of research.
2. *Pravda*, Jan 31, 1954.
3. W. Eason, "Population and labor force" in *Soviet Economic Growth*, A. Bergson, Ed., 1953, p. 110.
4. *Pravda*, Oct. 6, 1952; Jan. 31, 1954.
5. The technique of estimates is based primarily upon a detailed survey of annual graduation schedules of Soviet educational establishments. A few main sources are mentioned here: Gosplan, *Narodnoye Khozyaistvo* (Sbornik) [National Economy (Digest)], No. 2 (1949); No. 3 (1950), No. 4 (1951). E. Medynskii, *Narodnoye Obrazovaniye v S.S.S.R.* [Popular Education in the U.S.S.R.], 1952. *Bol'shaya Sovetskaya Entsiklopediya* [Large Soviet Encyclopedia], ed., 2 1952, vol. 9; S.S.S.R. vol., 1947. *Sotsialisticheskoye Stroitel'stvo, 1933–38* [Socialist Construction, 1933–38], 1939. *Kul'turnoye Stroitel'stvo, 1928–38* [Cultural Construction, 1928–38], 1940. A. Sinetskii, *Professorsko-Prepodavatel'skiye Kadry* [Teaching Staffs], 1950. *Vestnik Vysshei Shkoly* [Journal of Higher Education], 1946, No. 1, 10, 11–12; 1947, No. 4, 6, 11; 1949, No. 7; 1951, No. 3, 10. *Pravda*, Mar. 18, Oct. 16, 1946; Jan. 17, July 7, 1947; Mar. 13, June 27, 1948; Sept. 6, 1949; May 24, 1951; Jan. 29, May 24, June 14, 16, Sept. 1, Oct. 6, 1952; May 21, Oct. 26, 1953; Jan. 31, 1954. *Bol'shevik*, 1952, No. 12.
6. By average annual losses is meant "godovaya ubyl' po fizicheskim prichinam (smert', invalidnost') i otsev vvidu politicheskogo nesootvetstviya" [annual losses due to physical causes (death, invalidity) and political incompatibility] (*Vestnik Vysshei Shkoly*, 1948, No. 4, pp. 12–17, and Gosplan (Tsentral'naya komissiya po kadram), *Plan obespecheniya narodnogo khozyaistva S.S.S.R. kadrami spetsialistov (1929–33)* [The Plan of Providing the National Economy of the U.S.S.R. with a Cadre of Specialists, 1929–33], Moscow, 1930, pp. 24, 103). In the estimating process, average annual losses were used as coefficient k in the equation $T_n = (T_{n-1} - kT_{n-1}) - G_n$, where T_n is the number of trained specialists at the end of year n, T_{n-1} is the number of specialists at the end of the preceding year $(n-1)$, and G_n are graduations in the year n. The average annual losses among trained professionals were actually slightly more than 2 percent in the prewar (1930–40) period, while Soviet official sources for planning purposes describe their variation as being between 2 and 4 percent. If it is assumed that 2 percent average annual losses would have existed even if there were no war, then the losses (hypothetical war losses, 1941–45) attributable directly to the war were about 8 percent. Some independent checks (reported increases for several fields of professionals) were used in making this generalization and to verify the estimating technique.

6a. *Pravda*, May 19, 1954; *Izvestiya*, May 20, 1954. There are already indications that this surplus of secondary-school graduations over the available vacancies in higher educational establishments not only will have beneficial effects as far as the selection of candidates for higher educational establishments is concerned, but also will create its impact upon the modification and probable improvement of the standards of training of semiprofessional specialists in the so-called "technicums." It has already been revealed (*Izvestiya*, May 19, 1954) that probably up to 100,000 of this year's secondary-school graduates will enter "technicums" for specialized semiprofessional training.

7. A. Sinetskii, *Professorsko Prepodavatel'skiye Kadry* [Teaching Staffs], 1950; *Pravda*, Oct. 6, 1952.
8. *Bol'shevik*, No. 6, 1941; *Pravda*, Oct. 6, 1952.
9. C. Zirkle, ed., *Soviet Science*, 1952, is the only outstanding pioneering work in this direction that has appeared in recent years.

The rapid progress true Science now makes occasions my regretting sometimes that I was born so soon. It is impossible to imagine the height to which may be carried, in a thousand years, the power of man over matter. We may perhaps learn to deprive large masses of their gravity, and give them absolute levity, for the sake of easy transport. Agriculture may diminish its labor and double its produce; and all diseases may by sure means be prevented or cured, not excepting even that of old age, and our lives lengthened at pleasure beyond even the antediluvian standard. O that moral Science were in as fair a way of improvement, that men would cease to be wolves to one another, and that human beings would at length learn what they now improperly call humanity.—BENJAMIN FRANKLIN, in a letter to Joseph Priestley.

Natural Radiocarbon Measurements by Acetylene Counting

Hans E. Suess

U.S. Geological Survey, Washington 25, D.C.

DURING the past year a new standardized method for the determination of radiocarbon for age determinations has been developed and applied in the U.S. Geological Survey. The results of 65 determinations already carried out will soon be submitted for publication in this journal. The present report (*1*) describes the technique involving acetylene counting and the experiences with it.

The chemical steps in the preparation of the acetylene gas are the following:

1) Organic matter (wood, peat, etc.) $+ O_2$ / Carbonate (shells) $+ HCl \rightarrow CO_2$.
2) $CO_2 + 2NH_4OH \rightarrow CO_3(NH_4)_2 + H_2O$.
3) $CO_3(NH_4)_2 + SrCl_2 \rightarrow SrCO_3 + 2NH_4Cl$.
4) $2SrCO_3 + 5Mg \rightarrow SrC_2 + 5MgO + SrO$.
5) $SrC_2 + 2H_2O \rightarrow C_2H_2 + Sr(OH)_2$.

Steps 1 and 2 are carried out in essentially the manner described by Libby (*2*) but using one-third to one-half of the quantities. Instead of calcium chloride, strontium chloride is used in step 3 to precipitate the carbonate. Barium chloride can be used equally well, but preference was given to strontium chloride because of the possibility of a high radium content in commercial barium chloride (*3*).

Strontium carbonate, after washing and drying, can be directly reduced with an excess of magnesium powder (80 mesh) to strontium carbide. If enough material is available, a mixture of 30 g of $SrCO_3$ to 35 g of magnesium is used, yielding about 2.2 lit STP of C_2H_2 corresponding to a yield of 90 to 100 percent. The reaction is carried out inside an evacuated stainless-steel tube (2.8 by 38 cm) connected directly to a vacuum line through an O-ring seal. The mixture is ignited from the outside with a torch, and the reaction is completed in less than 5 min. The reaction product is then dumped into about 1 lit of water inside an evacuated system. The gases formed are dried by passing them through a trap cooled by an acetone mixture and a Drierite column. The acetylene is condensed in a liquid nitrogen trap, and some hydrogen that also forms is pumped off intermittently. After purification by passing over cooled charcoal, the acetylene is stored for 2 to 3 wk to permit the decay of the few hundred radon atoms that are sometimes present in the gas sample.

The gas counter is connected to a vacuum line. Its case and the "two mil" center wire is of stainless steel. For the past 9 mo no air has been admitted inside the counter. The inside diameter is 7 cm, and the effective volume is almost exactly 1 lit. It is surrounded by a mercury mantle of thickness 1.5 cm, by 11 cosmic-ray counters (2 by 20 in.), and by an iron shield of thickness 21 cm such as is described by Libby (*2*).

The principle of the low-level counting technique applied is that developed by Libby (*2*), which is the elimination of most of the cosmic-ray background by a ring of cosmic-ray counters in anticoincidence with the sample counter. The linear amplifier of a NICC methane counter model 117 is used for the amplification of the pulses. These are subsequently fed into an RCL anticoincidence circuit Mark 15 model 40 and registered. For control purposes, the total counts in the sample counter and in the 11 anticoincidence counters are also counted continuously. A separate negative high-voltage supply keeps the counter case at a potential of -2000 v against ground. The case is insulated by a Teflon sheet. The center wire obtains a positive voltage of 3000 v from the NICC counter so that the resulting total counting voltage is 5000 v. A 1000-w Sola constant-voltage transformer is used to maintain constant line voltage.

Table 1 gives the counts obtained with acetylene made from contemporaneous material and from coal. According to Libby (*2*), the specific activity of contemporaneous wood carbon is 15.3 ± 0.1 disintegrations/min. The effective counter volume contains 0.918 g of carbon in the form of acetylene and, therefore, 75.5 percent of the C^{14} disintegrations are recorded. Measurements for calibration purposes were combined in an effort to detect effects from industrial coal combustion on the specific activity of contemporaneous carbon (*4*). This work has not yet been concluded, and the results will be published at a later date.

Sample W-9 was remeasured during the 4 mo from Oct. 1953 to Mar. 1954 at intervals of 3 to 4 wk, and the four coal samples were measured during the same period of time. Table 2 shows the internal consistency of the individual readings. From this it appears that the observed fluctuations do not appreciably exceed the fluctuations to be expected from statistics. The number of counts in the sample counter in coincidence with the surrounding cosmic-ray counters varies between the extremes of 107 and 113 counts/min. The variations clearly show a period of 27 days, corresponding to the period of the solar component of cosmic radiation. The expectation that this variation of the cosmic-ray flux would reflect in the counter

Table 1. Total counts per minute and statistical standard error σ, determined in a counter of 1 lit effective volume filled with acetylene at a pressure of 72.3 cm of Hg made from contemporaneous and from "dead" carbon. Counting voltage 5000 v. The C^{13} concentration in the counter gas in terms of the deviation from limestone standard δ was determined by Harmon Craig.

Sample	Description	Age or years of growth from tree rings	Total counts/min	σ counts/min	δ C^{13} percent deviation from limestone standard (*5*)
W- 9	Hemlock, New Hampshire, cut 1950, obtained from E. G. Hutchinson	1840 to 1845	12.938	0.015	−2.68
W-13	Same tree as W-9	1945 to 1950	12.73	.05	−2.85
W-24	Spruce, Moses Point, Alaska, T. L. Péwé, coll., 1950	1890 to 1900	12.87	.05	−3.01
W-23	Same tree as W-24	1939 to 1950	12.75	.05	−3.81
W-14	*Venus mercenaria* shells, Nantucket Sound, coll. alive in 45 ft of water, H. J. Turner, coll.	1953	12.98	.05	−0.85
W-39	*Mya* shells, Sagadahoc Bay, Maine, W. H. Bradley, coll.	1950	12.82	.05	
W-25	Red Abalone shell, Santo Tomas, Baja California	1950	12.83	.05	
W-41	Land snail shells, *Triodepsis albilabris*, Ansonia, Conn., Barry McGuire, coll.	1952	12.62	.05	−2.61
W-34	Bituminous coal, Kentucky	Carboniferous	2.328	.04	
W-63	Same as W-34	Carboniferous	2.370	.03	
W-70	Lignite, Washington, D.C.	Cretaceous	2.325	.05	
W-80	Same as W-70	Cretaceous	2.387	.03	
	Average for coal		2.342	.012	

background seemed to be verified by initial runs, but it was not confirmed by later measurements. There is no noticeable correlation between coincidence counts and counter background.

In addition to the statistical counting error, the possibility of errors due to isotope fractionation and of contamination with carbon from atmospheric CO_2 in the chemical steps of sample preparation has to be considered. Craig (*5*), who has carried out mass-spectrometric C^{13} determinations of six acetylene samples, has found that a depletion of the heavier isotopes occurs, corresponding to a loss of C^{14} ranging from 1.5 to 3.5 percent of C^{14}. This loss will introduce the possibility of an error in the age of a sample of about ± 80 yr. Such an error is insignificant for old samples but may be important for precision measurements on young materials. A mass-spectrometric C^{13} determination is then required. The possibility of exchange with or adsorption of atmospheric CO_2 was demonstrated by allowing $SrCO_3$ prepared from coal to stand for 3 days in the open air. The acetylene prepared from it gave a counting rate 0.2 count/min above background. Although effects of that magnitude can easily be avoided, particular care has to be taken to avoid contamination with contemporaneous carbon in the case of very old samples.

Table 2. Deviation from the mean counting rate of all the individual readings taken, after counting times ranging from about 100 to 1000 min expressed in terms of the standard counting error of the individual readings. The figures in parentheses give the theoretical statistical expectation. None of the readings deviated by more than 3 σ.

Sample	Total no. readings	No. readings deviating from mean by: Less than 1 σ	More than 1 σ	More than 2 σ
Coal	32	21 (21.6)	11 (10.4)	0 (1.5)
W-9	19	14 (12.8)	5 (6.1)	3 (0.9)

The contamination of the counter gas with a few hundred radon atoms can occasionally be observed, which may introduce up to 0.1 count/min. Contamination with alpha activities, however, can easily be controlled by observing the alpha disintegrations at a reduced voltage of about 4000 v. The counting rate is surprisingly insensitive to traces of impurities such as air or CO_2 in the counter gas.

Comparison with other methods for C^{14} age determinations show (Table 3) that scintillation counting under optimal conditions will give results of greater precision with equal counting times. Compared with scintillation counting, however, the method described here has the following advantages: (i) a small amount of sample material is required; (ii) the acetylene

Table 3. Comparison of the different methods for the determination of natural radiocarbon (*6*).

	Solid carbon screen-wall counter (*3*)	Liquid paraffin 100 ml scintillation counter (*6*)	Gas counting 1 lit acetylene (*7*)
Sample size (wt. of carbon)	8 g	47 g	1 g
Counting efficiency (percent)	5.4	25	75
Net background (counts/min)	4	26	2.34
Net counts/min from modern carbon	6.7	182	10.72
Statistical error for modern carbon in years after 2 days of counting	± 120	± 17	± 50
Maximum age limit in years (4 σ) 2 days of counting	25,000	44,000	38,000

preparation requires less than 12 man-hours of labor; and (iii) the remarkable stability of the counting system and the reproducibility of the absolute counting rates eliminate the need for more than one check run every 2 to 3 wk.

Thanks are due to W. F. Libby for much helpful advice in general matters of C^{14} counting, and to N. Sugarman for valuable discussions on proportional counting.

References and Notes

1. Publication authorized by the director, U.S. Geological Survey.
2. W. F. Libby, *Radiocarbon Dating* (University of Chicago Press, Chicago, 1952).
3. W. R. Champion, U.S. Geological Survey, has kindly carried out radium determinations of commercial $SrCl_2$ and $BaCl_2$ and found the $BaCl_2$ usually about 100 times higher in Ra than the $SrCl_2$, which contains about 10^{-14} g Ra per gram $SrCl_2$.
4. H. E. Suess, paper presented at the NSF conference, Oct. 1953, Williams Bay, Wis.
5. Harmon Craig, *Geochim. et Cosmochim. Acta* **3**, 53 (1953).
6. See also J. R. Arnold, *Science* **113**, 155 (1954).
7. While this work was in progress. A. R. Crathorn [*Nature* **172**, 632 (1953)] attempted the use of acetylene as a counter gas for C^{14} determinations. For unknown reasons, however, a background of 30 counts/min was obtained with a 3-lit counter. This makes the use of his particular system impractical.

Metallo-Flavoproteins and Electron Transport

H. R. Mahler and D. E. Green

Institute for Enzyme Research, University of Wisconsin, Madison

ALTHOUGH the importance of metals in biological oxidations has been generally recognized (*1, 2*), there have been, until very recently, relatively few documented instances of the presence of metals in those oxidizing enzymes that have been isolated and characterized. Copper has been found to be the functional group of monophenol oxidase (tyrosinase) (*3*), polyphenol oxidase (laccase) (*4*), and ascorbic oxidase (*5*), while iron in the form of its porphyrin complex has been established as the functional group of catalase (*6*), peroxidase (*7*), yeast lactic dehydrogenase (*8*), and the cytochromes (*1, 9, 10*). This article summarizes some recent developments that provide additional confirmation of the pivotal role of metals in electron transport.

Metallo-flavoproteins are a group of enzymes containing both metal and flavin in firm linkage with the protein and in definite proportions. Thus far, seven enzymes have been characterized as metallo-flavoproteins, and three metals—copper, iron, and molybdenum—have been implicated as the functional metal. For simplicity of presentation, it may be desirable first to describe the general catalytic properties of each of these flavoprotein enzymes before considering the special function of the metal in the electron-transport sequence.

Acyl CoA dehydrogenases. Animal tissues contain two enzymes that catalyze the reversible oxidation of fatty acyl CoA's to their corresponding trans α,β-unsaturated derivatives (*11, 12*). Both have now been isolated from beef liver mitochondria in essentially homogenous state. One, which we shall refer to in this article as the *green enzyme,* is specific for the short-chain acyl CoA's from C_2 to C_8, while the other, which we shall refer to as the *yellow enzyme,* is active on all acyl CoA's from C_4 to C_{18}. Both enzymes contain flavinadenine dinucleotide as prosthetic flavin but differ in the nature of the prosthetic metal. The green enzyme contains copper (2 atoms per molecule of flavin), while the yellow enzyme may contain iron.

The absorption spectrum of the green enzyme shows the characteristic flavin bands at 355 and 432 mμ and, in addition, a new band at 680 mμ which is referable to copper or its appropriate complex. The deep green color of the enzyme stems from this band in the red end of the spectrum. When the enzyme is reduced by its substrate, both the flavin and copper bands disappear, and they reappear when the reduced enzyme is oxidized by molecular oxygen or other oxidizing agents. The absorption spectrum of the enzyme after removal of copper by mild procedures closely resembles that of a typical flavoprotein—that is, a flavo-

protein uncomplicated by the presence of functional groups other than flavin.

The yellow enzyme shows a typical flavoprotein spectrum in the oxidized state, but the spectrum of the reduced form is anomalous. A new broad band at 525 to 580 mμ appears on reduction of the enzyme. Whether the metal is implicated in this spectral change is as yet undecided.

The oxidation-reduction potential of the substrate system, acyl CoA-unsaturated acyl CoA, is about +0.25 v at *p*H 7.0 and 25°C. Because of this relatively positive potential, few of the conventional electron acceptors like methylene blue can be used for assay of the enzyme. Ferricyanide, some of the indophenols and quinones, and cytochrome *c* serve as satisfactory acceptors, but oxygen is far too sluggish.

Xanthine oxidase. This flavoprotein enzyme, which has been isolated from cow's milk in highly purified form, catalyzes the oxidation of hypoxanthine (and several related purines), aldehydes, DPNH (dihydrodiphosphopyridinenucleotide) and pterins (*13–17*). The lack of any obvious chemical resemblance between, for example, DPNH on the one hand and aldehydes and hypoxanthine on the other or between aldehydes and hypoxanthine has engendered considerable skepticism whether the same flavoprotein enzyme is responsible for all these oxidations (*16, 18*). Recent studies in our laboratory have confirmed the conclusion reached 15 yr ago that all these activities are associated with the same protein and that the same functional groups of the enzyme participate in each of the four oxidative reactions (*19*). Traditional concepts of sharp enzyme specificity admittedly are dealt a severe blow by these unusual properties of milk xanthine oxidase. No doubt it will tax ingenuity to provide a satisfactory explanation for this broad range of activities.

Westerfeld *et al.* (*20*) and De Renzo *et al.* (*21*) discovered that intestinal xanthine oxidase was relatively low in rats maintained on a molybdenum-deficient diet and that the level could be restored to normal by addition of minute amounts of molybdenum to the basal diet. These observations stimulated the search for molybdenum in xanthine oxidase. Several investigators have now confirmed the presence of molybdenum in xanthine oxidase—the molybdenum to flavin ratio being 1:2 (*22, 23, 24*) in the isolated purified enzyme. Since detachment of the metal from the protein can be shown to occur throughout the purification procedure used, this ratio in the native enzyme may be 1:1 or even greater. Similar considerations also obtain for the aldehyde oxidase described in later paragraphs.

Concentrated solutions of milk xanthine oxidase are brownish red in color, whereas typical flavoproteins are lemon yellow. Indeed, assay of the enzyme for flavin as flavinadenine dinucleotide discloses that flavin can account for no more than 40 percent of the total absorption at 450 mμ. The residual absorption at 450 mμ is referable to a second chromophoric substance in the enzyme molecule that is as yet unidentified (*15, 19, 25*). This substance, which is metal free and cannot readily be split off from the protein, shows a band at 415 mμ and absorbs generally throughout the rest of the visible spectrum. Molybdenum makes no contribution to the spectrum since the spectrum of the molybdenum-free enzyme is indistinguishable from that of the original enzyme.

One of the most perplexing features of xanthine oxidase has been the observation, first made in 1938, that the prosthetic flavin is not reduced rapidly enough to accommodate the hypothesis that flavin is reduced and oxidized during the catalytic cycle of the enzyme (*15*). This dilemma has finally been resolved. Morell has shown (*18*) that on addition of hypoxanthine or aldehyde a fraction of the flavin (less than 60 percent) is rapidly reduced, whereas the remaining oxidized flavin is only slowly reduced. In our laboratory evidence has been obtained (*19*) that the partial reduction of flavin is a consequence of an equilibrium between two oxidation-reduction systems—that of the substrate and that of the enzyme. The potential of the couple, reduced enzyme-oxidized enzyme, (E_0' of −0.45 v at *p*H 7.0 and 38°C) is more negative than that of the couples, hypoxanthine-xanthine (E_0', −0.37 v), xanthine-uric acid (E_0', −0.36 v), and DPNH-DPN$^+$ (E_0', −0.32 v). The couple of the system, aldehyde-acid, has not been measured but is estimated to be below −0.4 v. The slow reduction of all the enzyme-bound flavin which follows the initial quick reduction is probably an irreversible process that has no bearing on the normal state of the enzyme. Either loss of metal from the reduced enzyme or reduction of the metal to a lower valency state than is normally involved could explain this slow "overreduction."

The oxidation-reduction potential of the xanthine oxidase enzyme couple, which is several hundred millivolts more negative than that of simple flavoproteins or flavinadenine dinucleotide, may reflect a contribution of molybdenum to the potential. Perhaps the enzyme couple consists of the components, Mo^V, $FADH_2$-Mo^{VI}, FAD.

The xanthine oxidase system is not only indiscriminate with respect to the types of substrates oxidized but shows equal lack of partiality to electron acceptors. Molecular oxygen, oxidation-reduction dyes, ferricyanide, cytochrome *c*, nitrate, and quinones are all equally effective. The enzyme also catalyzes the interaction of the reductant of one substrate with the oxidant of a second—for example, oxidation of hypoxanthine or aldehyde by DPN or oxidation of aldehyde by uric acid as shown by the equations:

$$\text{Hypoxanthine} + \text{uric acid} \rightleftharpoons 2\ \text{xanthine}, \quad (1)$$

$$2\ \text{aldehyde} + \text{uric acid} \rightarrow 2\ \text{acid} + \text{hypoxanthine}, \quad (2)$$

$$\text{Hypoxanthine} + 2\ \text{DPN}^+ \rightleftharpoons \text{uric acid} + 2\ \text{DPNH}, \quad (3)$$

$$\text{Aldehyde} + \text{DPN}^+ \rightarrow \text{acid} + \text{DPNH}. \quad (4)$$

Liver aldehyde oxidase. A flavoprotein has been isolated from pig liver that catalyzes the oxidation specifically of aldehydes by the same group of acceptors as are effective with xanthine oxidase (*26*). Three pros-

thetic groups have been found to be present in the enzyme at the highest purity level (> 90 percent), namely, flavinadenine dinucleotide, molybdenum, and iron-protoporphyrin in the ratio of 2:1:1 (*27*). As a result of repeated precipitations of the purified enzyme, both metal and hemin can be progressively detached from the enzyme, and thus in the limit only flavin remains attached to the protein.

The absorption spectrum of the enzyme is compounded of contributions from both hemin and flavin. The effect of the high Soret band of hemin is to blur the characteristic flavin bands at 360 and 450 mμ. Unlike the flavin of the xanthine oxidase, the flavin moiety of aldehyde oxidase is completely reduced in the rapid phase. The hemin moiety may be the determinant of the relatively positive potential of the enzyme couple. The aldehyde oxidase enzyme couple may consist of the components: Mo^{V}, $FADH_2$, Fe^{++} (hemin)-Mo^{VI}, FAD, Fe^{+++} (hemin). Hemin by virtue of its relatively positive potential would thus have the effect of shifting the equilibrium in favor of complete reduction of flavin by aldehyde.

DPNH-nitrate reductase. Nason *et al.* have isolated from Neurospora a flavoprotein enzyme that catalyzes the oxidation of TPNH by nitrate (*28*). A molybdenum requirement emerges with purification of the enzyme. Whether nitrate is the only electron acceptor for this flavoprotein still has to be determined. In this connection it is of interest to point out that xanthine oxidase can also qualify as DPNH-nitrate reductase by virtue of catalyzing the oxidation of DPNH by nitrate. The reduction of nitrate may well be a peculiarity of molybdo-flavoproteins.

Hydrogenase. Many bacteria contain an enzyme that catalyzes the reversible oxidation of molecular hydrogen by oxygen, dyes, cytochrome *c*, and nitrate (*29–31*). The resemblance of the electron-acceptor pattern of hydrogenase to that of xanthine and aldehyde oxidases suggested to us the possibility of hydrogenase being a molybdo-flavoprotein. Some recent studies of Wilson *et al.* (*32*) appear to confirm this prediction. An unequivocal requirement for molybdenum has been shown for the reaction of hydrogen with cytochrome *c*. Purified preparations of the enzyme from *Clostridium pasteurianum* have the brownish-red appearance similar to that of milk xanthine oxidase.

DPNH cytochrome reductase. Two flavoprotein enzymes, both of which have been isolated from pig heart muscle, are concerned in the oxidation of DPNH. One (diaphorase) catalyzes the oxidation by dyes such as indophenols (*33–35*), while the other (DPNH cytochrome *c* reductase) reacts with cytochrome *c* as well as with dyes (*36, 37*). Apart from this difference, as far as electron acceptor is concerned, there are other differences which appeared to eliminate the possibility that diaphorase is a derivative of DPNH cytochrome *c* reductase. The former is a fluorescent flavoprotein containing FAD as prosthetic group, while the latter is a nonfluorescent flavoprotein whose flavin prosthetic group is a dinucleotide not identical with FAD. Furthermore, diaphorase contains no metal, whereas the reductase contains 4 atoms of iron per molecule of flavin (*38*).

The question of the possible identity of these two flavoproteins was reopened with the discovery that after removal of iron from DPNH cytochrome *c* reductase, the capacity to react with cytochrome *c* was lost and the metal-free derivative enzyme was thus functionally indistinguishable from diaphorase, although a difference still existed with respect to fluorescence and the nature of the flavin prosthetic group (*39*). The possibility has to be entertained that DPNH cytochrome *c* reductase under one set of conditions can be converted to classical diaphorase and under another set of conditions to the nonfluorescent diaphorase that arises following removal of iron from reductase.

Coincident with reduction of the flavin of DPNH cytochrome *c* reductase, the metal atoms are converted to their ferrous forms, while during oxidation of reduced flavin the metal atoms are converted to their ferric forms. There is no evidence of the presence of iron-porphyrin in DPN cytochrome *c* reductase. The iron atoms, therefore, are in a form for which there is no precedent among oxidation enzymes apart from the case of acyl CoA dehydrogenase and of tryptophan peroxidase, which has recently been shown (W. E. Knox, personal communication) to contain iron in a nonhematin form.

The absorption spectrum of the enzyme in the oxidized state does not depart significantly from that of typical flavoproteins. There is evidence of a band at 525 to 600 mμ in the reduced form which is similar to that shown by the reduced acyl CoA dehydrogenase (yellow enzyme).

Interaction of metal and protein. Considerable differences exist among metallo-flavoproteins with respect to the ease with which the prosthetic metal can be reversibly detached. Copper is not dissociable from the green enzyme either during the purification procedure or on storage of the enzyme for long periods of time. Only by prolonged dialysis against cyanide is it possible to remove copper from the enzyme. On the other hand, molybdo-flavoproteins readily part with their metal even under relatively mild conditions, such as dialysis against dilute ammonia or repeated precipitations with ammonium sulfate. Iron as in DPNH cytochrome *c* reductase is intermediate between copper and molybdenum as far as ease of detachment from the protein is concerned.

The apoenzymes show very sharp specificity for the metal. Thus iron cannot reactivate the copper-free acyl CoA dehydrogenase, nor can copper reactivate the iron-free DPNH cytochrome reductase. Similarly, neither iron nor copper nor any of a long list of other metals can substitute for molybdenum in reactivating metal-free xanthine or aldehyde oxidase, with the exceptions noted in the following paragraphs.

Certain metals closely related to molybdenum in their electronic structure and in their chemical reactivity can replace it, however, to a certain extent. Thus tungstate can replace molybdic oxide at about 50-per-

cent efficiency in the case of aldehyde oxidase, while uranyl ions can substitute for molybdenum to the extent of 10 percent in the case of xanthine oxidase. But the situation cannot be reversed: uranyl is inactive for aldehyde oxidase, while tungstate cannot replace molybdenum in the case of xanthine oxidase. This high degree of specificity with respect to the metal utilized is unique, both in the field of metal complexes and in that of other metal-activated enzymes. The protein must therefore exert a considerable selectivity in the binding, and the binding site must show a highly oriented steric configuration.

The number of molecules of metal necessary for full reactivation of 1 molecule of apoenzyme is far higher (up to 5000 times) than the molecular ratio of the two in the unresolved enzyme. This discrepancy between the concentration in the enzyme and the concentration to which the apoenzyme has to be exposed for maximal reactivation is not an unfamiliar one in studies of conjugated enzymes. Enzymes that have lost their prosthetic metal may not bind metal again by the same linkages as were involved in the original enzyme. In other words, the metal is no longer held in the same firm linkage as in the unmodified enzyme. Molybdenum poses a special difficulty with respect to the form in which the metal can be presented to the apoenzyme. Molybdenum does not exist as the simple metal ion in solution. In the form of molybdate it may be a far cry from the correct state of the active metal. In point of fact, molybdic trioxide is active under conditions where molybdate is completely inactive.

Function of the metal. The study of the seven metallo-flavoproteins described in foregoing paragraphs has revealed a very consistent pattern for the role of metal to which no exception has yet been found. The metal plays no role in the interaction of the reduced enzyme with organic oxidation-reduction dyes, quinones, and molecular oxygen. These reactions go on equally well whether the metal is present in or removed from the enzyme. It should be noted that all these oxidizing agents require 2 electrons for a reductive step. However, metal is required absolutely for the interaction of reduced enzymes with 1-electron acceptors such as cytochrome *c* and ferricyanide. Nitrate is the one apparent exception to this rule. However, since there is no knowledge of the steps involved in the enzymatic conversion of nitrate to nitrite and since N^{IV}(as in NO_2) is certainly a possible valency state for the first intermediate in the conversion, there is at present no basis for deciding how serious an exception nitrate is to the rule that metal plays a role exclusively in the interaction of reduced flavin with 1-electron acceptors. It should be added that nitrate reduction is a phenomenon confined to the molybdoflavoproteins—a fact that suggests complexing between metal and nitrate.

The foregoing facts call to mind Shaffer's equivalence theory (*40*), which is based on observations that are variations of the following case. A reductant involving a valency change of 2 electrons reacts slowly, if at all, with an oxidant involving a valency change of 3 electrons. The interaction can be catalyzed by a mediator involving a 1-electron valency change. The mediator facilitates the stepwise removal of electrons from reductant to oxidant and overcomes the energy barrier imposed by the necessity for simultaneous collision of multiple molecules of reductant and oxidant. The Shaffer theory is not strictly applicable to the metallo-flavoproteins, since both the metal mediator and the oxidant undergo the same valency change, namely, 1 electron. However, the Shaffer theory does point up a difficulty of mechanism inherent in the transfer of electrons from a member of one valency group of oxidation-reduction system to a member of another valency group. The function of the metal may be to complex simultaneously with 1 molecule of flavin and 2 molecules of acceptor. In this sense, the metal would be facilitating a ternary collision.

There is another aspect of the problem that may warrant consideration. The reactions between reduced flavoproteins and their respective electron acceptors have been, heretofore, regarded as one-step oxido-reductions. The implication of metal ions in this process has in effect introduced additional steps. There is some evidence that the 4 iron atoms in DPNH-cytochrome reductase are not equivalent but belong to two different groups. The electron flow may be represented by the following sequence, where arrows indicate the directions of electron flow:

Substrate → flavin → metals of group I → metals of group II → acceptor.

Since, in the presence of appropriate enzymes, this sequence is capable of being tapped, at least in theory, at each intermediate step, additional parameters have been introduced into a process which by virtue of its stark simplicity appeared forbidding of ever yielding to a study of mechanism.

Little has been said so far about the structural aspects of metallo-flavoproteins. The metal forms coordination covalencies not only with the flavin nucleotide but also with the protein. At least in the case of cytochrome reductase, the inference is strong that two of the valencies of the iron atom are able to chelate with cytochrome *c*. It is tempting to generalize from this observation and to postulate that metals capable of linking two or more catalytically active proteins by chelation play a role not only in the initial but also in the ultimate stages of electron transport.

Albert's observations on the complexing of metal ions by riboflavin (*41*) have been the starting point for some further studies in our laboratory which bear on the structural features of chelation. We have found that the flavin nucleotide coenzymes are even more effective complexing agents for iron than riboflavin proper. When a flavin nucleotide and ferrous ammonium sulfate are incubated with the iron-binding globulin of human plasma, an artificial "ferro-flavoprotein" is formed (*39*). A complex of this sort shares many of the properties of the enzymatically active metallo-flavoproteins, such as absorption spectrum. Removal of the iron, however, invariably leads to com-

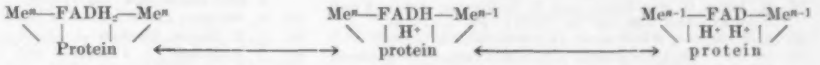
plete dissociation of the complex. This is not the case with the metallo-flavoprotein enzymes. There it is frequently possible to split out the metal and leave the flavin still bound to the protein. From this we have concluded that, although the protein-metal-flavin link is indubitably of importance, flavin must be linked to the protein by additional bonds as well.

The interaction of reduced molybdo-flavoproteins with 1-electron acceptors such as cytochrome *c* or ferricyanide does not proceed in the absence of added inorganic phosphate. Arsenate replaces phosphate to a small degree. The full meaning of this phosphate requirement has yet to be clarified, but the possibility that phosphate esterification accompanies valency changes in the metal is not unlikely. The intervention of a metal in the electron-transport sequence may thus provide a mechanism for phosphate esterification.

In this connection it may be of significance that other ions that are capable of forming strong complexes with Mo^{V}, such as silicate, can replace phosphate, while others that are isosteric with it but incapable of interaction with the metal, such as sulfate or perchlorate, are ineffective.

The recent study of Wosilait *et al.* (*42*), as well as the classical investigations of Wieland (*43*) and Booth (*44*), has directed attention to the useful features of quinones as electron acceptors particularly for flavoprotein enzymes. The oxidation-reduction potentials of a large number of quinones have been determined and several series of compounds of related chemical structure, covering a wide range of potential, are readily available. It has been shown recently that quinones can be used as electron acceptors for a wide variety of flavoproteins (*45*). In general the velocity of interaction of any one enzyme with a series of quinones increases as the potential of the quinone becomes more positive, until maximum velocity is attained above a critical potential value. The effect of the metal on this relationship is both pronounced and consistent. The potential plateau is changed by about ±50 mv when metal is present compared with the situation when metal is removed from the enzyme. Furthermore, the slope of the log velocity-potential plot is much steeper in the absence of metal. From these facts, we have concluded that metal plays a determinant role in the potential of the flavoprotein enzyme system and that the metal profoundly influences the reaction characteristics of the flavin with which it is associated.

A metallo-flavoprotein should, therefore, be regarded as an entity and not simply as a loose aggregate or complex of the three components—metal, flavin, and protein. Thus at all times, in the native enzyme, the metallo-flavin, together with the amino acids surrounding the site of its attachment to the protein, forms part of the same resonating system. The mobile π-electrons of this unit are distributed over a considerable volume. For this reason 1-electron intermediates (the semiquinones of Michaelis) arising during catalysis may have considerable stability even at physiological *p*H values and may prove to be of importance mechanistically. An alternative formulation might be to regard the reduced form of a flavoprotein, as written ordinarily, as only one of several possible resonance forms, some of which may carry the semiquinone structure implicit in their structure, for example,



During active catalysis, a further enlargement of the resonating system takes place to include π-electrons not only of the metallo-flavoproteins but also those associated with the substrate and/or electron acceptor. In this manner, the transfer of electrons from one part of this essentially intramolecular system (the substrate) to another (the acceptor) is facilitated considerably.

References

1. O. Warburg, *Heavy Metal Prosthetic Groups and Enzyme Action* (Clarendon Press, Oxford, 1949).
2. A. L. Lehninger, *Physiol. Rev.* **30**, 393 (1950).
3. F. Kubowitz, *Biochem. Z.* **292**, 221 (1937); D. Keilin and T. Mann, *Proc. Roy. Soc.* (*London*) **B125**, 187 (1938).
4. ———, *Nature* **143**, 23 (1938).
5. G. B. Ramasarma, N. C. Datta, and N. S. Doctor, *Enzymologia* **8**, 108 (1945); E. Stotz, *J. Biol. Chem.* **133**, C (1940); P. L. Lovett-Janison and J. M. Nelson, *J. Am. Chem. Soc.* **62**, 1409 (1940).
6. K. Zeile and H. Hellstrom, *Z. physiol. Chem.* **192**, 171 (1930); D. Keilin and E. F. Hartree, *Proc. Roy. Soc.* (*London*) **B121**, 173 (1936); K. G. Stern, *J. Biol. Chem.* **112**, 661 (1936).
7. R. Kuhn, D. B. Hand, and M. Florkin, *Z. physiol. Chem.* **201**, 255 (1931); D. Keilin and T. Mann, *Proc. Roy Soc.* (*London*) **B122**, 119 (1937); H. Theorell, *Arkiv. Kemi, Mineral., Geol.* **14B**, No. 20 (1940).
8. S. J. Bach, M. Dixon, and L. G. Zerfas, *Biochem. J.* (*London*) **40**, 229 (1946).
9. C. A. MacMunn, *Trans. Roy. Soc.* (*London*) **177**, 267 (1886); C. A. MacMunn, *Z. physiol. Chem.* **13**, 497 (1889) and **14**, 328 (1890).
10. D. Keilin, *Proc. Roy. Soc.* (*London*) **98B**, 312 (1925); K. Zeile, *Z. physiol. Chem.* **207**, 35 (1932).
11. H. Beinert *et al. J. Am. Chem. Soc.* **75**, 4111 (1953); H. R. Mahler, *Federation Proc.* **12**, 694 (1953); W. Seubert and F. Lynen, *J. Am. Chem. Soc.* **75**, 2787 (1953).
12. D. E. Green *et al., J. Biol. Chem.* **206**, 1 (1954); H. R. Mahler, *J. Biol. Chem.* **206**, 13 (1954).
13. H. J. Coombs, *Biochem. J.* (*London*) **21**, 1259 (1927).
14. M. Dixon, *Biochem. J.* (*London*) **20**, 703 (1926); *Enzymologia* **5**, 198 (1938).
15. H. S. Corran *et al., Biochem. J.* (*London*) **33**, 1699 (1939).
16. O. H. Lowry, O. A. Bessey, and E. J. Crawford, *J. Biol. Chem.* **180**, 399 (1949).
17. H. M. Kalckar and H. Klenow, *J. Biol. Chem.* **172**, 349 (1948); ———, N. O. Kjeldgaard, and H. Klenow, *Biochim. et Biophys. Acta* **5**, 575 (1950).
18. D. B. Morell, *Biochem. J.* (*London*) **51**, 657 (1952).
19. B. Mackler, H. R. Mahler, and D. E. Green, *J. Biol. Chem.*, in press.
20. W. W. Westerfeld and D. A. Richert, *Science* **109**, 68 (1949); *J. Biol. Chem.* **184**, 163 (1950); **192**, 35, 49 (1951).
21. E. C. De Renzo *et al., J. Am. Chem. Soc.* **75**, 753 (1953).
22. D. E. Green and H. Beinert, *Biochem. et Biophys. Acta* **11**, 599 (1953).
23. E. C. De Renzo *et al., Arch. Biochem. Biophys.* **45**, 247 (1953).
24. J. R. Totter *et al., Science* **118**, 555 (1953).
25. E. G. Ball, *J. Biol. Chem.* **128**, 51 (1939).
26. A. H. Gordon, D. E. Green, and V. Subrahmanyan, *Biochem. J.* (*London*) **34**, 764 (1940).
27. H. R. Mahler, B. Mackler, and D. E. Green, *J. Biol. Chem.*, in press.

28. D. J. D. Nicholas and A. Nason, at AIBS meetings, Madison, Wis., Sept. 1953; D. J. D. Nicholas, A. Nason, and W. D. McElroy, *Nature* **172**, 34 (1953); A. Nason and H. J. Evans, *J. Biol. Chem.* **202**, 655 (1953).
29. M. Stephenson and L. H. Stickland, *Biochem. J.* (*London*) **25**, 205, 215 (1931); **26**, 712 (1932).
30. D. E. Green and L. H. Stickland, *Biochem. J.* (*London*) **28**, 898 (1934).
31. H. Gaffron, *Am. J. Botany* **27**, 273 (1940).
32. P. W. Wilson *et al.*, *J. Am. Chem. Soc.*, in press.
33. D. E. Green and J. G. Dewan, *Biochem. J.* (*London*) **32**, 626 (1938).
34. E. Adler, H. von Euler, and H. Hellstrom, *Arkiv. Kemi, Mineral., Geol.* **12B**, No. 38 (1937); No. 5 (1938).
35. F. B. Straub, *Biochem. J.* (*London*) **33**, 787 (1939).
36. H. Edelhoch, O. Hayaishi, and L. J. Teply, *J. Biol. Chem.* **197**, 97 (1952).
37. H. R. Mahler *et al.*, *J. Biol. Chem.* **199**, 585 (1952); L. P. Vernon, N. K. Sarkar, and H. R. Mahler, *J. Biol. Chem.* **199**, 598 (1952).
38. H. R. Mahler and D. Elowe, *J. Am. Chem. Soc.* **75**, 5769 (1953).
39. H. R. Mahler and D. Elowe, *J. Biol. Chem.*, in press.
40. P. Shaffer, *Cold Spring Harbor Symposia Quant. Biol.* **7**, 50 (1939).
41. A. A. Albert, *Biochem. J.* (*London*) **54**, 646 (1953).
42. W. D. Wosilait, A. Nason, and A. J. Terrell, *J. Biol. Chem.* **206**, 271 (1954); W. D. Wosilait and A. Nason, *J. Biol. Chem.* **206**, 255 (1950).
43. H. Wieland and W. Mitchell, *Ann.* **492**, 156 (1937).
44. V. H. Booth, *Biochem. J.* (*London*) **29**, 1732 (1935).
45. H. R. Mahler, A. Fairhurst, and B. Mackler, in preparation.

Attitudes of College Seniors toward Federal and Industrial Employment

Lowell H. Hattery and Charles M. Hersh

The American University, Washington 6, D.C.

ATTITUDES of graduating seniors in engineering, science, and social science were assessed in the spring of 1952 by The American University (*1*). The purpose was to study the reasons why graduates did or did not take Federal employment (*2*). The research grew out of a pilot investigation by George P. Bush which indicated the need for further investigation of student attitudes and extension of the study to additional major fields (*3*).

We administered a questionnaire to seniors, faculty and placement officers in field visits to five colleges and universities (*4*). The questionnaire was supplemented with interviews, primarily with faculty and placement officers, for background information and opinions. Final assessment of student attitudes was based solely on responses to the questionnaire. For this reason, its development should be discussed briefly.

The Questionnaire

The questionnaire was designed to accomplish objectives established by the University committee directing the research. These objectives were

1) To measure the students' degree of preference for Federal employment as compared with industrial employment

2) To discover the extent to which students' attitudes concerning the advantages and disadvantages of Federal and industrial employment (derived from interview and questionnaire comment in the pilot study) influence student job decisions

3) To discover (i) the sources of information concerning employment which influence the student as he makes his job decision and (ii) the relative values that he assigns to these sources

4) To discover (i) the attitudes of faculty members toward the factors of employment influencing students, (ii) faculty members' sources of information, and (iii) the relative values they assign to these sources

5) To compare (i) student and faculty attitudes and sources of information and (ii) attitudes of engineering students with those of science and social science students

6) To determine the time when college seniors make their final decision to accept or reject specific employment opportunities

The questionnaire included questions to provide information concerning student behavior in the recruitment process, such as the time of job decision, amount of salary received, and sources of information about employment opportunities. For the analysis of attitudes 38 statements concerning industrial and Federal employment were presented in the form of a Likert-type scoring schedule. The student was asked to indicate his agreement or disagreement with the statement. Five degrees of agreement or disagreement were provided.

The 38 items were based on statements that students themselves had used in the pilot study. Several statements were included in each of the following areas: benefits, pay, promotion, job security, recruitment, professional development, and working conditions. Examples of the statements are

Experience gained in Federal employment becomes a poor recommendation for future work in industry.

Opportunities for additional training in my professional field are greater while working in private industry than in government.

A person working for the Federal Government in my field has a greater job security than in private industry.

In my field, individual initiative on the job is given higher recognition in government than in similar industrial work.

For each of these, and for the 34 additional statements, the student was asked to check one of five boxes for "Strongly disagree" with this statement, "Tend to disagree," "Neither agree nor disagree, or don't know," "Tend to agree," or "Strongly agree." Finally, the student was asked to indicate which of the statements described the factor that was most important in his job choice.

Employment Decisions

It was rather surprising to find that, in a year of very active recruitment, only 38 percent of the 660 seniors said they had definitely accepted civilian jobs at the time of our visits in late April and early May. Approximately 21 percent expected to go into graduate or professional school, and 16 percent expected to go into the armed forces. Thus as late as April–May approximately 25 percent could be presumed still available for employment.

Most students in the fields surveyed either made or expected to make final job decisions in April and May, with approximately 30 percent accepting employment in each month. A few accepted employment during their junior year, and about 14 percent from October through March of the senior year. The recruiting process for college seniors is therefore a year-round function, even though most students finally accept employment in the spring.

With reference to the selection of industrial or Federal employment, the preference was distinctly in favor of industrial employment. Among those who had definitely accepted jobs, three of four students (77.8 percent) selected jobs in industry; only one of twenty (5.2 percent) chose Federal employment. The remainder chose educational employment (4.8 percent), other types (9.9 percent), or did not answer this question (2.4 percent).

There were substantial variations among institutions with respect to the selection of industrial or Federal employment. For example, 45 seniors at one school had definitely accepted jobs at the time of our visits; none chose Federal employment. At another, 6 students of 46 who had definitely accepted jobs chose Federal employment.

Among those who had definitely accepted employment, approximately 5 percent of the engineering majors, 4 percent of the science majors, and 14 percent of the social science majors chose Federal jobs.

These differences in preference indicate that Federal agencies are under a substantial handicap in attracting and recruiting college seniors in certain institutions and certain major fields.

Attitudes toward Employment

Measurement of students' attitudes also indicates strong preference for industrial, as compared with Federal, employment. Only 13 percent of the seniors' attitude scores were more favorable to Federal than to industrial employment.

Seniors' attitudes toward Federal, as compared with industrial, employment vary with their fields of college major. For example, students majoring in mechanical engineering averaged attitude scores more favorable to industry than those students who accepted jobs in industry, whereas political science majors averaged attitude scores as favorable toward Federal employment as those students who chose Federal jobs. When the eight fields of college major were combined into three, it was discovered that, although they all favored industrial employment, those in engineering favored industry most, science majors favored industry with less intensity, and social science majors favored industry with still less intensity.

Seniors' previous employment experience affects their attitudes toward employment. Those with previous experience in industry are significantly more favorable toward industrial employment than are those without such experience. Seniors with previous employment in the Federal Government hold attitudes favorable toward industrial employment but with much less intensity than other students. Their attitude scores approach neutrality. On the other hand, 57 students claimed previous employment experience in *both* industry and the Federal Government. Their attitudes were as favorable toward industry as those of students with industrial experience alone.

Many students had participated in summer training programs in industry or the Federal Government. Both groups' attitudes were favorable to industrial employment. The intensity of favor for industry was, however, significantly less among those seniors who had participated in Federal training programs.

When one examines the response to individual items among the 38 attitudinal statments, those which students select as most favorable toward industrial or Federal employment provide a basis for analyzing the differences in attitudes toward these fields. The ten statements upon which seniors' responses were most favorable toward industrial employment, in decreasing rank order, are

Pay for higher level positions
Students with greatest ability more likely to enter
Incentive for employee to work
Students more inclined to work for industry
General management efficiency
Pay dependent upon ability
Management efficiency in my field
Employee works harder
General professional development
Competent immediate supervisors

The ten statements upon which seniors' responses were most favorable toward Federal employment, in decreasing rank order, are

Individual works "under pressure" less frequently
Experience good recommendation for future work in industry
Liberal vacation policy
Liberal sick leave policy
Beneficial retirement system
Job security
Equipment for technical work
Discrimination against individual less likely
Geographic location of positions
Employment more likely to be permanent

Important Factors in Employment Decisions

Students were asked to indicate the factors that they considered most important in the choice of employment. The results of this inquiry were then related to the responses to the 38 statements of attitude. No student regarded benefits as his most important consideration. Job security was held most important by only 6 percent of the students. These two content areas, containing several statements in each, were the areas of response most favorable to Federal employment. Thus it was found that *seniors regarded industrial employment more favorably than Federal employment in the considerations that are most important to them in choosing a job.*

Information on sources of employment advice was collected which is significant for those persons who are concerned with recruitment. This description of sources of advice was compared with students' ranking of sources of information concerning specific Federal and industrial job opportunities (Tables 1 and 2). The recruitment representative was considered the most important source of advice in deciding whether or not to accept a job. Industrial representatives were regarded as the most important source of information concerning specific industrial job opportunities. Federal representatives ranked third in importance as sources of information concerning specific Federal job opportunities. Thus, industrial recruitment, in the student's view, is oriented toward the source most valuable to the student, the representative who visits the campus. Federal recruitment is not as effectively oriented around the representative, according to the student's evaluation.

Table 1. Seniors' sources of information concerning job opportunities.

Source	Federal job opportunities*	Industrial job opportunities*
Placement office	20.5	24.4
Newspapers, radio, and television	19.4	7.1
Representative who visited campus	13.5	30.6
Faculty members	10.5	8.0
Other students	8.2	4.7
Family	6.8	8.5
Other sources and no response	21.2	16.7

* Numbers indicate percentage of seniors regarding source to be the most important.

Table 2. Seniors' most important source of advice in job choice.

Source	Percentage of seniors
Representative who visited campus	26.4
Faculty members	20.8
Family	12.6
Placement office	7.7
Other students	4.1
Newspapers, radio, and television	2.0
Other sources and no response	26.5
Total	100.1

Faculty and Placement Officer Attitudes

In addition to analysis of seniors' attitudes, a less intensive study was made of the attitudes of faculty and placement officers. Questionnaires were received from 107 faculty members. These were supplemented by interviews with both faculty and placement officers.

Questionnaire results showed faculty members slightly less favorable toward industry than seniors but still much more favorable to industry than to government as a place for employment. Interviews supported these findings.

The conclusion from this questionnaire study is that college seniors and their major sources of information and advice are more favorable to industrial employment than to Federal employment. Students believe that the factors most important to their job decisions are found in industry rather than in government.

To be realistic, Federal personnel policies must take cognizance of the attitudes of students and faculty and provide a strong recruitment program if the Federal agencies are to attract their share of scientific talent. Planning scientific manpower to meet the requirements of the Federal service needs to be government-wide and long-range.

References and Notes

1. This article is based on research conducted by The American University and supported by funds from the Office of Naval Research. C. M. Hersh was the principal investigator and chairman of a University committee for the project, composed of C. Seckler-Hudson, L. H. Hattery, G. P. Bush, H. H. Roth, and R. T. Bower.
2. For a full report of findings, see C. M. Hersh, *College Seniors and Federal Employment* (The American University, Washington, D.C., 1953).
3. The Bush study was concerned with civil, mechanical, and electrical engineers. See G. P. Bush, *Engineering Students and Federal Employment* (The American University, Washington, D.C., 1951). For a summary of the Bush report, see G. P. Bush and L. H. Hattery, "Federal Recruitment of Junior Engineers," *Science* **114**, 455 (1951).
4. The institutions visited were Johns Hopkins University, Oberlin College, Purdue University, Syracuse University, and West Virginia University.

News and Notes

Work of the UNESCO Advisory Committee on Arid Zone Research

Another step in the promotion of collaboration among scientists dealing with problems of the world's arid zones was taken at the Seventh Session of the Advisory Committee on Arid Zone Research in Paris on 4–7 May. The arid zones, if defined as land areas with a deficit in the moisture index exceeding 20, according to the Thornthwaite classification [*Geograph. Rev.* **38**, 55 (1948)], comprise somewhat more than one-quarter of the earth's land area. Although sparsely populated over great expanses, they also include several densely populated irrigated valleys, such as the Nile and the Tigris-Euphrates, and the sites of many other, now abandoned, desert settlements. Because the natural environment of these areas has much in common and because the means of maintaining or extending their stable human use are still uncertain, large advantage is likely to be gained from furthering the exchange of research methods and findings of scientists and engineers now at work in them.

UNESCO established the Advisory Committee in 1950 to advise on framing and carrying out a program for stimulating research on the problems of those zones. It is composed of one member each from nine nations, the terms of members running 2 yr and rotating among interested nations. Present membership includes a botanist from Italy, a geographer from Turkey, an irrigation engineer from Syria, a physicist from Mexico, an electrical engineer from India, a soil microbiologist from the United Kingdom, an agronomist from Australia, and the writer. The membership from France is vacant because of death. Representatives of various international scientific groups and of the Food and Agriculture Organization, the World Health Organization, and the World Meteorological Organization took part in the recent sessions.

The program tries in six different ways to help research workers cut across national boundaries: (i) reports on common problems, such as ground-water hydrology, are commissioned from scientists in various parts of the arid zones and published in a single volume; (ii) international symposia on such problems are sponsored jointly with an interested national group in alternate years; (iii) financial support is given in the other years to symposia sponsored by national groups; (iv) a list of arid zone research institutions is published with the assistance of the interested governments; (v) international scientific cooperation is enlisted in preparing suggestions for methods of field study; and (vi) small grants are made in support of especially meritorious research projects having international significance. [For details, see J. Swarbrick, *Impact of Sci. on Soc.* **4**, 221 (1953)].

The range of work so far sponsored is indicated by the subjects of publications already released or in press. These books, which may be purchased in the United States through the Columbia University Press, New York 27, include *Reviews of Research on Arid Zone Hydrology, Reviews of Research on Problems of Saline Water, Reviews of Research on Arid Zone Plant Ecology* (in press), and *Proceedings of the Montpellier Symposium on Arid Zone Plant Ecology* (in press).

At the recent session plans were reviewed for a series of papers to be prepared during the next year on problems of animal and human ecology. Plans also were reported for a symposium on "Wind and solar energy in the arid zones" to be held in Oct. 1954 in New Delhi, with the joint sponsorship of the Government of India. It is hoped that this symposium may direct attention to the most promising ways of economically harnessing these energy sources. In a country such as India where the search for fuel causes the destruction of watershed vegetation and the burning of potential fertilizers, a partial solution of the problem would have tremendous implications for use of natural resources.

Financial aid was recommended to pay the travel expenses of a few foreign scientists to attend a symposium and conference to be held by the AAAS in New Mexico on 27–28 Apr. 1955, on the occasion of the annual meeting of the Southwest Section of the Association [*Science* **119**, 869 (18 June 1954)].

There was preliminary discussion of ways in which experience might be pooled with respect to the cheapest and most effective means of making integrated field surveys of resources in arid regions. With the exception of reconnaissance studies in Australia and more elaborate studies in the United States, there is not a great deal of experience in relating the work of scientists in several disciplines in a unified survey. This will come up again at the next session.

No recommendations were made for support of major new research projects, although some attention was given to questions of the occurrence and collection of dew and to ecological studies in the Rajasthan desert of India.

The Committee is experimenting in ways of promoting genuinely creative and imaginative approaches to the scientific problems of the arid zones. Suggestions from scientists on specific problems deserving attention or on other methods of fostering collaboration will be welcome.

GILBERT F. WHITE
Haverford College, Haverford, Pennsylvania

Science News

With the present issue, ***Science*** begins its 120th volume. In the volume just completed—the 119th, January–June 1954—there appeared 958 pages of text and editorial material, exclusive of advertising pages, this being the largest number for any volume of the last decade. It exceeds by more than 100 pages the next largest volume in this 10-yr period; and by more than 375 pages, the smallest volume.

Arrangements for four additional special studies to be conducted by federal and private survey groups as part of the broad **National Science Foundation survey of science** in the United States have been announced. The new projects are described below.

Survey of industrial research and development. The planning phase of this study will be conducted by the Bureau of Labor Statistics, U.S. Department of Labor, in close cooperation with the staff of the NSF and under the direction of a steering committee composed of staff members of the two agencies. It will include a review of previous studies and development of questionnaire and interview forms for getting additional desired information on industrial research. The questionnaire will be pre-tested with the aid of a selected list of firms in various industrial fields.

The ultimate scope of the study will be to develop data on research personnel, capital investment in research facilities, and the relationship of research expenditures to corporate sales and invested capital. Also, information will be sought on how companies determine the size of research programs, how they appraise the return on research, and the effect of taxes and other government policies on industrial research.

Survey of research by state governments. This study will be done in two parts: (i) by the Bureau of the Census, U.S. Department of Commerce, and (ii) by the Institute for Research in Social Science, University of North Carolina. The Census Bureau plans to analyze the pertinent information already available in its files and supplement the results with additional investigations in one state. From this exploratory study the Bureau expects to construct a suitable pattern of investigation for studying state-financed and controlled research throughout the country. The Institute at North Carolina will participate in the analysis of the experience of the Census Bureau and will conduct the follow-up investigations in other states. Information will be gathered on research costs, manpower, administration, and research content of state-supported programs.

Survey of research by trade associations and similar organizations. This study will be conducted by the Battelle Memorial Institute, Columbus, Ohio. There are approximately 16,000 trade associations in the United States, and it is believed 200 to 400 of these conduct or support research programs in the physical and biological sciences. A somewhat larger number have research programs in economics and other social science fields. In addition, the study will include certain professional societies that conduct research programs, largely supported by industry, and other types of cooperative industrial research organizations.

Survey of research at nonprofit institutes and commercial laboratories. This study will be conducted by the Maxwell Research Center at Syracuse University. It will explore the research programs of the 50 to 100 independent nonprofit research institutes and the estimated 250 to 400 commercial research laboratories in the United States. In many instances these organizations are concerned with research of interest to industry, but they differ from industrial laboratories in that their principal business is research, with manufacturing, if any, secondary to research.

In addition to these special surveys, the staff of the Foundation is now conducting two major studies of research supported or sponsored by the Federal Government and by American universities and colleges. The Foundation's broad survey of the current status of science and research in the United States will cover all types of organizations conducting, supporting, or sponsoring research in this country. It will include all branches of physical and biological science, including medicine, as well as certain areas of the social sciences. Information will be collected primarily on current activities, but some historical information will be gathered extending back to 1925.

The broad survey will provide the background information on research trends that is needed by many groups in the development of effective national science policies and for the promotion of research and education in the sciences. The Foundation is making such studies pursuant to the national Science Foundation Act of 1950, highlighted by the recent Executive Order issued by President Eisenhower on 17 Mar. 1954. The completion date for the survey has been tentatively set for the end of 1955. Interim reports will be issued as parts of the general survey are completed. A summary report will be published at the completion of the survey.

A preliminary report of a **new test for uterine and cervical cancer** was made to the Chicago Gynecological Society by S. A. F. Lash and Ralph W. Gerard of the University of Illinois, and G. Falk of the University of Chicago. The test, a simple one, involves measuring the electric potential difference between the inside and outside of single cells cast off from the vaginal tract. The measuring technique is one that Dr. Gerard has used for many years in his basic research in nerve physiology.

The positive and negative readings, when properly interpreted, were found to reveal whether the patient had cancer of the uterus or of the cervix. In the first series of 57 cases, the test indicated that 20 of the women had cancer; 18 of these latter were proved to have cancer, and two really did not. The test showed that 35 women did not have cancer, and it was right in every case. In further trials, there has never been a false negative test, and the positives were about 94 percent correct. It is hoped that the new method will make earlier diagnosis possible. However, the report stresses that the test is purely in the research stage; it will not be known for at least a year whether it will be worth using clinically.

An accelerated program to study all aspects of the **radiation sterilization of foods** is being undertaken by the Army Quartermaster Corps for the benefit of the Armed Forces. The 5-yr program will have the active participation of the Atomic Energy Commission, elements of the Armed Forces, and other governmental

agencies as well as four educational and industrial institutions. The long-range objective is to learn whether or not irradiation may be substituted for present food preservative treatments by heat, chemicals, and other processes without detracting from the natural odor, color, flavor, and texture of the foods. Should the investigations prove successful, the results may be radical changes in the packaging and processing of many foods, decreasing the use of refrigeration and extending storage life.

Basic research already has been accomplished by the Army Quartermaster Corps as well as by the U.S. Navy, the AEC, the Department of Agriculture, and numerous industrial and educational laboratories. As a result of this expanded program to be coordinated by the Army Quartermaster Corps, the AEC has announced it will discontinue its individual research program in the food technology aspects of this field.

The National Research Council has appointed a special Advisory Committee to the Quartermaster Corps on Radiation Sterilization to assist the program. The committee includes: Joseph Butts, AEC; L. V. Clifcorn, Continental Can, Inc.; Gail Dack, University of Chicago; Glen King, Nutrition Research Foundation; H. S. Mitchell, Swift and Co.; and Bernard Proctor, Massachusetts Institute of Technology.

High-speed photography can be used to solve problems of **improper dynamic reactions** in design of springs, according to an article by John H. Waddell in the May issue of *Mechanical Engineering*. High-speed photography, he said, has shown the way to simple corrections in such operations as engine valve lifters and electrical relays. Stroboscopic studies, in many instances, will not work.

A new approach to **Gulf Stream investigations** was initiated on 9 June by the Woods Hole Oceanographic Institution with the sailing of the 142-ft research vessel *Atlantis* and the departure of an amphibious airplane on loan from the U.S. Navy. While the *Atlantis* worked her way toward Cape Hatteras, where the Gulf Stream first was crossed, the PBY, manned by a civilian crew and scientists, made an aerial survey of the location and path of the Gulf Stream from a point due south of Cape Cod to Cape Hatteras. The meandering position of the current was reported by radio to the ship for her guidance.

On board the plane William S. Richardson, chief scientist, used a radiation thermometer to find the inshore edge of the current. This device measures the surface temperature of the ocean by registering the incoming infrared radiation and comparing it with the radiation from a water sample in the plane that could be heated or cooled.

On board the *Atlantis*, Willem V. R. Malkus, chief scientist, allowed the vessel to drift with the main body of the Gulf Stream. Constant maneuvering was necessary to keep the ship, which moved approximately 100 mi per day for 8 days, in the swiftest flowing part of the current.

Field tests were made of a new instrument that was designed at Woods Hole. Called a Bathypitotmeter, this device measures the current at various depths below the surface. It is of importance to oceanographers to find the speed and direction of subsurface water in the Gulf Stream, and no satisfactory instrument for such measurements has been available in the past. Though observations have been made from anchored ships, this is a difficult and time consuming operation.

Thorne Deuel, director of the Illinois State Museum, has announced that a rock shelter which was occupied by prehistoric Indians nearly 11,000 yr ago has been found about 40 mi south of St. Louis, Mo. This is believed to be the **oldest dated Indian home east of the Mississippi.** The ancient site was unearthed by highway maintenance crews.

The age was determined by carbon 14 tests on charcoal samples taken at a depth of 26 ft. Willard Libby of the Institute of Nuclear Studies, University of Chicago, determined the date of the lowest level to be 8697 B.C. ± 650 yr. Other dates determined were 6592 B.C. for samples found at 22 ft and 4001 B.C. at the 16-ft level. Frederick R. Matson of Pennsylvania State University, representing the Wenner-Gren Foundation of New York City, collected the samples. The excavation, sponsored by the Illinois State Museum, the Illinois State Museum Society, the University of Chicago and the Wenner-Gren Foundation, was carried on in 1952 and 1953.

Karl T. Compton, one of this country's most eminent scientists and a key figure in the development of the atomic bomb, died on 22 June. Chairman of the corporation of Massachusetts Institute of Technology since 1949, he was that organization's president for 18 yr. Dr. Compton served on the Executive Committee of the AAAS from 1929 to 1940 and was the Association's president in 1935.

Scientists in the News

George H. Berryman has been appointed head of the department of clinical investigation at Abbott Laboratories. He joined the department in 1951.

George L. Buc, formerly of the Tidewater Oil Co., has accepted appointment as technical assistant to the president of Fisher Scientific Co. Dr. Buc will continue as editor of the journal *Applied Spectroscopy*.

H. R. Gault is returning to Lehigh University as professor of geology after having spent a year's leave of absence as executive secretary of the Division of Earth Sciences, National Research Council. He will continue his work on carbonate rocks and basic rock alteration.

John T. Goodwin, Jr., formerly a production and development chemist in the silicones products department of the General Electric Co. in Waterford, N.Y., has been appointed manager of the chemistry research

division of the Midwest Research Institute, Kansas City.

George H. Hepting of the Southeastern Forest Experiment Station of the U.S. Forest Service, recently received a silver medal for his superior service in forest pathology. He directs the tree-disease research program at six field laboratories in the southern states; he has been with U.S. Department of Agriculture since 1926. Outstanding accomplishments by Dr. Hepting and his Division of Forest Disease Investigations include: discovery of a new pine rust; determination of the cause of serious wilts of sugar maple and mimosa; discovery and development of a strain of wilt-resistant mimosa; determination of methods for avoiding butt rot in sprout oak stands; relation of the littleleaf disease of shortleaf pine to nitrogen supply, carbohydrate production, soil permeability, and *Phytophthora* killing of rootlets; determination of soil types on which pine can be grown without loss from littleleaf; demonstration of control of oak-leaf blister by dormant sprays; and recognition of *Fusarium lateritium* f. *pini* which stimulates gum flow from Virginia pine. His division also has done important work on oak wilt in the Appalachians and on correcting decay conditions in wooden trainer planes and gliders and in wooden Naval vessels.

Details of a detonator widely used for sabotage during World War II recently have been revealed with the announcement that physicist **A. J. G. Langley** has been given a cash award by the British Royal Commission on Awards to Inventors. The miniature "time pencil" detonator invented by Mr. Langley, who conducted research for the British Navy throughout the war, was made by the millions. Since the war, Mr. Langley has been director of scientific intelligence for Canada's Defense Research Board; he is now executive assistant to the general manager of Computing Devices of Canada Ltd., Ottawa.

C. M. Louttit, assistant to the provost and professor of psychology at the University of Illinois, has resigned to accept the chairmanship of the department of psychology at Wayne University, effective in September.

Basil W. Parker, professor of biology at Lehigh University, became head of the department of biology on 1 July. He succeeds **Stanley J. Thomas** who will continue as professor of biology.

Cash Blair Pollard, professor of chemistry in the University of Florida and consulting toxicologist, has won the 1954 Florida Section award of the American Chemical Society. The award is conferred annually for outstanding contributions to chemistry by a chemist or chemical engineer of the southern states. Dr. Pollard is widely recognized for his research on quinine, infant deafness, and snake venoms, and also as an expert witness in legal cases involving the scientific investigation of crime.

Edwin A. Popenoe, formerly of the Cornell University Medical College, New York, has joined the biochemistry division of the medical department at Brookhaven National Laboratory. At Cornell, Dr. Popenoe was a member of the group headed by Vincent du Vigneaud that was first to work out the structure of the peptide hormone vasopressin.

Two scientists are among those retiring at Mt. Holyoke College this year. **Mary Lura Sherril,** professor of chemistry and chairman of the department, withdraws from service after having been on the faculty since 1921. In 1947 she received the American Chemical Society's Garvan Medal for achievement in research and teaching. **Edith Barstow,** assistant director of the chemistry laboratories is also retiring. She first joined the college staff in 1911.

The following are among those who have recently received **honorary doctoral degrees.**

Philadelphia College of Pharmacy and Science: **Ralph A. Connor,** vice president in charge of research, Rohm and Haas Co.; **Ernest Volwiler,** president of Abbott Laboratories.

University of Chicago: **Peyton Rous,** Rockefeller Institute for Medical Research; **Joel Stebbins,** professor emeritus of astronomy, University of Wisconsin.

Union College: **Edwin L. Crosby,** executive director of the American Hospital Association.

Stevens Institute of Technology: **Edward L. Cochrane,** vice president of Massachusetts Institute of Technology; **Morse G. Dial,** president of Union Carbide and Carbon Corp.; **Daniel Mapes,** vice president of Walter Kidde and Co.; **Benjamin J. Lucarelli,** president of the B. J. Lucarelli Co., Inc.

Lehigh University: **Monroe J. Rathbone,** president of Standard Oil Co. of New Jersey; **Karl Terzaghi,** professor of the practice of civil engineering, Harvard University.

Ohio State University: **Edwin Sharp Burdell,** president of the Cooper Union; **Jack A. Morton,** director of transistor development, Bell Telephone Laboratories.

North Carolina State College: **Walter J. Damtoft,** vice president, Champion Paper and Fibre Co.; **J. W. Turrentine,** president emeritus, American Potash Institute.

University of Toledo: **Robert B. Sosman,** professor of ceramics at Rutgers University; **Frederick H. Norton,** professor of ceramics at Massachusetts Institute of Technology.

Beloit College: **Carey Croneis** former president of Beloit College and professor of geology at Rice Institute.

Howard College: **P. R. Bell,** head of the electronics group in the physics division of Oak Ridge National Laboratory.

Albany Medical College of Union University: **Robert A. Moore,** vice chancellor of the Schools of Health Professions of the University of Pittsburgh and professor of pathology.

Rutgers University: **Oswald T. Avery,** retired member of the Rockefeller Institute for Medical Research;

George W. Beadle, chairman of Division of Biology at California Institute of Technology and president-elect of the AAAS; **Robert E. Buchanan,** retired director of the Agricultural Experiment Station and dean of the Graduate College at Iowa State College; **Albert Jan Kluyver,** professor of microbiology, Technical University, Delft, The Netherlands; **Richard E. Shope,** Department of Animal Pathology, Rockefeller Institute for Medical Research; **Jacques Trefouel,** director of the Pasteur Institute in Paris; **Cornelius B. Van Niel,** professor of biology at Stanford University and president of the Society of American Bacteriologists; **Hans Karl Von Euler-Chelpin,** professor of general and organic chemistry, University of Stockholm.

Springfield College: **Norman L. Munn,** professor of psychology, Bowdoin College.

Meetings

The **American Meteorological Society** will hold its 130th meeting, 24–25 Aug., at Rochester, New York. The emphasis will be on agricultural and industrial meteorology. Those having papers to present should immediately contact Mr. Alfred Stiller, 48 Berkshire St., Rochester, N.Y.

The 131st national meeting of the AMS will take place at Columbus, Ohio, on 8–10 Sept. In addition to one or more general sessions, special sessions on atmospheric pollution, bioclimatology, climate in relation to building and city planning, and meteorological education are being planned. For information write to Prof. Nelson Dingle, Department of Physics and Astronomy, The Ohio State University, Columbus 10.

In the near future the **American Oil Chemists' Society** will sponsor two events of interest to the oil and fat industry: the sixth short course, to be held at Lehigh University, 15–20 Aug., on "Inedible fats and fatty acids," with Daniel Swern of Eastern Regional Research Laboratory, Philadelphia, as chairman; and the 28th annual fall meeting, to be held in Minneapolis, 11–13 Oct., with J. C. Konen of Archer-Daniels-Midland Co. as chairman.

The jubilee conference of the **Association of Applied Biologists** will be held at Imperial College, South Kensington, London, 13–15 Sept. followed by visits to research stations on 16 and 17 Sept. In the course of a program of symposia and lectures covering most of the subjects with which the Association has been concerned, many prominent biologists from Britain and overseas will review the past achievements of applied biology and discuss its present trends and future potentialities. For information write to R. K. S. Wood, general secretary, Botany Department, Imperial College, London, S.W. 7.

The life and accomplishments of the late **Edwin Bret Hart** received recognition at the annual meeting of the Institute of Food Technologists held in Los Angeles 29 June. Prof. Hart died in 1953. He had retired from the chairmanship of the University of Wisconsin department of biochemistry in 1944 after 38 yr of teaching and research. He was a pioneer in the development of the science of nutrition, and it was under his direction that vitamin A was discovered and its function established. He also contributed to knowledge of the B vitamins.

At the meeting a panel of five scientists and former students of Hart spoke on his work, and the name of the Babcock award for work in food technology was officially changed to bear the names of both Hart and of Stephen Moulton Babcock, Wisconsin scientists who devised the butterfat test for milk and who conducted pioneer investigations in the field of biochemistry.

Former students of Prof. Hart who participated in the program were H. T. Scott of the Wisconsin Alumni Research Foundation; Conrad A. Elvehjem, chairman of the University of Wisconsin biochemistry department and dean of the UW Graduate School; S. Lepkovsky of the University of California; E. M. Nelson of the Food and Drug Administration, Washington, D.C.; and K. G. Weckel, professor in the UW department of dairy and food industries. L. E. Clifcorn of the Continental Can Company, Chicago, served as chairman of the panel.

Fisk University is sponsoring its 5th annual **Infrared Spectroscopy Institute** from 30 Aug. to 3 Sept. These institutes are planned to introduce chemists, biologists, physicists, and engineers to the usefulness of infrared spectroscopy in research and in teaching. This summer particular emphasis will be placed on the application of infrared and Raman spectroscopy to problems of industrial research.

Morning sessions will be devoted to introductory lectures, evenings to lectures on more advanced topics, and afternoons to laboratory work. A feature of the week's study will be a panel discussion on the merits of the different spectrometers now commercially available. Laboratory facilities will include a variety of single-beam and double-beam spectrometers of both instructional and commercial design. Instruments for the "overtone" region (1 to 3 μ) as well as the "rock-salt" region (3 to 15 μ) will be available.

The faculty will include Walter Brown, TVA Research Laboratories, Wilson Dam, Alabama; Ivar Cooke, University of Geneva, Switzerland, now at Fisk; Nelson Fuson, Fisk University; Ernest A. Jones, Vanderbilt University; Wilbur Kaye, Tennessee Eastman Research Laboratory; and James R. Lawson, Tennessee A and I State University. For further information write to Prof. Nelson Fuson, Fisk University, Nashville, Tenn.

The **Luminescence of Biological Systems** was the subject of a recent conference arranged by the National Research Council's Committee on Photobiology, with the support of the National Science Foundation. A limited number of investigators representing various avenues of approach, from the purely physical to the purely biological, met near Pacific Grove, Calif., to examine both comprehensively and in detail our present knowledge and future problems in this field.

The following topics, in particular, were presented and critically discussed: "A survey of luminous organisms: problems and prospects" by E. Newton Harvey; "Luminescence spectroscopy of molecules and the photosynthetic system" by Ralph S. Becker and Michael Kasha; "On the light saturation of delayed light production in green plants" by William Arnold; "Fluorescence of photosynthetic pigments" by C. Stacy French; "Spectroscopic investigations of luminescent systems" by C. J. P. Spruit and A. van der Burg (Holland); "Recent studies on the chemistry of Cypridina luciferin" by F. I. Tsuji, Aurin M. Chase, and E. Newton Harvey; "Biochemistry of firefly luminescence" by Wm. D. McElroy and J. Woodland Hastings; "Firefly luciferin" by Bernard L. Strehler; "Factors and biochemistry of bacterial luminescence" by Bernard L. Strehler; "Purification and properties of bacterial luciferase" by J. Woodland Hastings and Wm. D. McElroy; "Inhibition and activation of intracellular luminescence" by Frank H. Johnson; "Physiological control of luminescence in animals" by J. A. C. Nicol; "Some reflections on the control of bioluminescence" by John Buck; "Luminous organisms of Japan and the Far East" by Yata Haneda and Yokosuka Museum (Japan); "The ecology of autotrophic marine dinoflagellates, with reference to red water conditions" by John H. Ryther; "Bioluminescence in Gonyaulax polyhedra" by Francis Haxo and Beatrice Sweeney.

Additional data were contributed in further discussions by these authors and by other members of the conference, including Rubert Anderson, E. R. Baylor, Lawrence Blinks, Demorest Davenport, L. M. V. Duysens, Arthur Giese, Walter J. Kauzmann, Howard S. Mason, C. B. van Niel, E. J. Ferguson Wood (Australia), and C. E. ZoBell.

The papers on the afore-mentioned topics, along with the chief discussions, will be published by the AAAS as a Symposium Volume under the editorship of F. H. Johnson.

Technical, business, scientific, and industrial photographers throughout the country are invited to submit prints for the annual technical exhibit of the Photographic Society of America's technical division. The exhibit—the **10th Open Exhibit of Technical Photography** sponsored by the PSA—will be shown as a part of the 1954 PSA International Exhibition of Photography to be held in Chicago, 5–9 Oct. *Closing date for entries is 15 Aug.* Entry forms and additional data may be obtained by writing to Donald B. Grim, Exhibits Director, 31 Eglantine Rd., Rochester, N.Y.

The 31st **Plant Science Seminar** will take place at the University of Connecticut, 18–21 Aug. For details write to Dr. A. E. Schwarting, University of Connecticut College of Pharmacy, Storrs, Conn.

The National Science Foundation has awarded Harvard University a grant to permit the holding of a seminar on **"Problems in comparative behavior,"** from 5–16 July. The primary purpose of the conference will be to permit European zoologists to exchange information with biologists and psychologists in this country. Visitors from abroad are expected to be Prof. van Iersel of Leiden University, The Netherlands; G. P. Baerends of Groningen University, The Netherlands; and Robert A. Hinde of Cambridge University, England. The conference is being organized by William S. Verplanck of the psychology department.

The annual meeting of the **Society of General Physiologists** will be held at the Marine Biological Laboratory, Woods Hole, Mass., on 8–9 Sept. A symposium on "Electrolytes in biological systems," dedicated to W. J. V. Osterhout and M. H. Jacobs, has been organized by A. M. Shanes. Included among the speakers are Dean Cowie, Richard Roberts, George Scott, Aser Rothstein, Gilbert Mudge, Daniel Tosteson, Abraham Shanes and Ernst Huf. The second day of the meeting will be devoted to contributed papers, of which 16 are scheduled. Anyone desiring accommodations in the MBL dormitories for the period of the meetings should make reservations well in advance through Homer P. Smith, business manager of the Laboratory. Further information on the program may be obtained from the secretary, John Buck, National Institutes of Health, Bethesda, Md.

The Society will also hold a sectional meeting on 30 Dec. in connection with the meetings of the Western Society of Naturalists and the AAAS in Berkeley. Albert Tyler of California Institute of Technology is in charge of arrangements.

Society Elections

New officers of the **American Economic Association** are pres., Simon Kuznets, University of Pennsylvania; sec.-treas., James Washington Bell, Northwestern University. The vice presidents are Roy Blough, United Nations, and Arthur Smithies, Harvard University.

The **American Educational Research Association** has elected the following officers: pres. H. H. Remmers, Purdue University; v. pres., Francis G. Cornell, University of Illinois; sec.-treas., Frank W. Hubbard, NEA Research Division.

Current officers of the **American Physical Society** are pres., H. A. Bethe, Cornell University; v. pres., R. T. Birge, University of California; treas., G. B. Pegram, Columbia University; sec., K. K. Darrow, Columbia University.

Officers of the **American Psychoanalytic Association** are: pres., Ives Hendrick; pres.-elect, Maxwell Gitelson; sec., Richard L. Frank; treas., Robert T. Morse.

The **American Society for Testing Materials** has elected the following officers: pres., Norman L. Mochel, Westinghouse Electric Corp., Philadelphia; v. pres., Rudolph A. Schatzel, Rome Cable Corp., Rome, N.Y.

The **American Society of Animal Production** has elected the following officers: pres., A. E. Darlow,

Oklahoma A & M College; v. pres. J. I. Miller, Cornell University; sec.-treas., W. M. Beeson, Purdue University.

Officers of the **American Society of Photogrammetry** for 1954 are: pres., Arthur C. Lundahl; 1st v. pres., W. Sidney Park; 2nd v. pres., Robert N. Colwell; sec.-treas., C. Earl Palmer.

The **Illinois State Academy of Science** has elected these officers for 1954–55: pres. Garrett W. Thiessen, Monmouth College; 1st v. pres., Leland Shanor, University of Illinois; 2nd v. pres., Annemarie Krause, Southern Illinois University; sec., Lyle E. Bamber, University of Illinois; treas., Walter B. Welch, Southern Illinois University. The representative to the AAAS Council is Percival Robertson, The Principia.

The **Institute of Mathematical Statistics** has elected the following officers: pres. E. G. Olds; pres.-elect, Henry Scheffé; sec.-treas., K. J. Arnold.

The **Institute of Physics,** 47, Belgrave Sq., London, S.W. 1, has elected the following officers: pres., Sir John Cockroft; v. pres., G. R. Noakes.

New officers of the **Minnesota Academy of Science** are: pres., L. A. Ford, State Teacher's College, Mankato; v. pres., William H. Marshall, Institute of Agriculture, St. Paul; sec.-treas., Blanchard O. Krogstad, St. Olaf College, Northfield.

The **Ohio Academy of Science** has elected the following officers: pres., Rush Elliott, Ohio University; sec., R. W. Dexter, Kent State University; treas., R. M. Geist, Capital University.

Officers of the **Society for Experimental Stress Analysis** are: pres., Marshall Holt, Aluminum Co. of America; sec.-treas., W. M. Murray, Massachusetts Institute of Technology. The vice presidents are S. S. Manson, National Advisory Committee for Aeronautics, and M. M. Leven, Westinghouse Electric Corp.

Education

A new curriculum designed to prepare men for careers in the distribution areas of modern industry will be initiated next fall at **Clarkson College of Technology.** The 4-yr course, combining the essential elements of the engineering sciences with those of business administration, will lead to the B.S. degree. Thirteen new courses were devised to meet the special needs.

Affiliation of the Chicago Tumor Institute with the University of Chicago has been announced. Identity of the institute will be continued by designation of the fifth, or radiation therapy floor of the Nathan Goldblatt Memorial Hospital of the University Clinics as the **Chicago Tumor Institute of the University of Chicago.**

The centennial year of the **Emory University School of Medicine** will be recognized in a special celebration 4–5 Oct. Daniel C. Elkin, chairman of the department of surgery, is chairman of the centennial committee. The program will feature a series of lectures by prominent physicians, among them Alan Gregg, director of medical sciences for the Rockefeller Foundation. At a formal academic ceremony, several honorary degrees will be conferred.

The **Massachusetts Institute of Technology** has announced plans for a nuclear reactor, New England's first, to be privately financed and devoted solely to education and unclassified research in the peacetime applications of nuclear power. At the appropriate time, approval of the Atomic Energy Commission will be sought for the allocation of the necessary fuel. The estimated total cost of the reactor laboratory will be about $1,000,000. Coupled with this new reactor project are plans for a $4,000,000 building for the physical sciences.

The **National University of Cuyo in Argentina** recently established a Mathematics Institute to stimulate basic research in mathematics and related subjects. The institute will cooperate with similar organizations in other Latin-American countries in considering problems of common concern.

This year some 1100 general contractors engaged in construction in North Carolina have invested more than $35,000 in the **North Carolina State College Engineering Foundation.** Unique in the nation, the new construction curriculum at N.C. State was conceived by the Carolinas Branch of the Associated General Contractors of America. Designed largely by and completely for the construction industry, this 4-yr curriculum will lead to a construction degree in civil engineering.

The American Society for Metals has just completed a survey of teaching activities and student enrollment in the areas that provide the **personnel for metallurgy.** The survey explains the principal reason for a shortage of metallurgical engineers and points up an obligation on the part of both higher education and industry to give greater emphasis to, and broader understanding of, the role played by metallurgical engineers.

There are now approximately 2300 students enrolled in our engineering schools who aspire to a Bachelor's degree in metallurgical engineering. Those who actually graduate in 1954 may well number less than 10 percent of the total. Taking into consideration possible changes in careers and other deviations, the total might well be reduced by still another 20 percent. This is far from being an adequate answer to the present problem of shortage, which is estimated at more than 2000. Candidates for advanced degrees also enter into the ASM survey. A separate study was conducted to determine how many students planned to do postgraduate work. Forty-seven engineering schools offering postgraduate courses in metallurgy reported that a total of 747 were carrying on post-

graduate studies in metallurgy. If an expected 90 percent of these advanced degree holders actually pursue metallurgical activities, American industry will still require approximately 1500 additional metallurgists and metal scientists. It is estimated that industry now needs more metallurgical engineers than will be graduated during the next 5 yr.

In recognition of the increased use of radiation and the associated health protection problems, the Public Health Service, U.S. Department of Health, Education, and Welfare, sponsors a **radiological health training program** at the Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio. Its purpose is to acquaint public health workers with the significance of ionizing radiations, the environmental and occupational hazards attendant on their use, and recommended procedures for minimizing such hazards. Although designed primarily for professional personnel of state and local health departments, a limited number of qualified applicants from other government agencies and industry will be welcome.

The following courses are scheduled for 1954–55: 1–5 Nov., "Problems of radioactivity in waterworks"; 10–21 Jan., "Basic course in radiological health"; 24 Jan.–4 Feb., "Occupational radiation protection"; 7–10 Mar., "Radiation hygiene—preventive medical aspects"; 18–29 Apr., "Basic course in radiological health"; 2–13 May, "Environmental radiation sanitation course"; 16–20 May, "Problems of radioactivity in waterworks." For further information address the Chief, Radiological Health Training Section, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, Ohio.

Grants and Fellowships

The following **AAAS research grants** have been awarded:

Colorado-Wyoming Academy of Science: to M. M. Douglas, ecology of the limber pine; to D. Stratton, papers of Albert B. Fall.

Illinois State Academy of Science: to E. Bennett, ecological survey in Durango, Mexico; to T. C. Dorris, limnological study of the middle Mississippi River in relation to certain navigation structures and practices; to D. Franzen, holotypes, cotypes, and paratypes of gastropod molluscs of Illinois; to Sister M. J. Preising, anaodic oxidation of sugars to carbon dioxide and water; to C. J. Rohde, Jr., life histories of soil-inhabiting micro-arthropods.

Minnesota Academy of Science to A. Grewe, lake sedimentation at Itasca State Park.

New Hampshire Academy of Science to P. Doe, synthesis of 4,4-distributed piperdines by the use of the Guareschi Imide reaction.

New Orleans Academy of Science to J. E. Tampesta, purification, isolation, and testing of the pharmacological properties of a glycoside which has marked cardiac action.

Monica Reynolds, assistant professor of physiology in the School of Veterinary Medicine of the University of Pennsylvania, has been awarded a $2000 fellowship by the **American Association of University Women.** She has been granted a year's leave of absence to work at the National Institute for Research in Dairying at Reading, England; she will study milk formation in bovines to determine the relationship between blood circulation in the udder and the volume and composition of milk secretion.

The **American Viscose Corp.** will include 29 institutions in its college relations program for the academic year 1954–55. This is an increase of seven over last year's list of colleges and universities receiving fellowships, scholarships, and grants-in-aid. The funds available for the 1954–55 program will approximate $55,000.

Fifteen graduate fellowships have been established in the fields of chemistry, accounting, organic chemistry, cellulose chemistry, forestry, pulp technology, and paper technology. Twenty-four scholarships for undergraduates are divided among chemistry, engineering, physics, textiles, accounting, chemical engineering, business administration, textile technology, and mechanical engineering. The selection of recipients is left to the faculty of each institution. The individuals selected are under no obligation of any kind to the corporation.

The **Damon Runyon Memorial Fund** allocated $36,400 during May.

Harlem Hospital, New York. J. C. Wright. Tissue culture investigations of human neoplasms, $10,000.

University of Minnesota. O. H. Wangensteen. The "second-look" operation for patients with gastric colic or rectal cancer, $15,000.

Providence College. F. D. K. Hickey. Metabolism of cholesterol-labile digitonin precipitable metabolites of acetate in the chick embryo and living rat liver tissue, normal, regenerating and tumerous, $1000.

Montreal Cancer Institute. A. Cantero. Relative distribution of mononucleotides in nucleic acids, and intracellular distribution of enzymatic activity in normal and neoplastic liver tissue, $5000.

State Unviersity of New York. T. G. Li. X-ray absorption study of the protein content of carcinoma; *in situ* cells of the human cervix as compared to normal cells, $5400.

A broad survey of the usefulness of plastics as a material for housing will be the subject of a research program now being organized at the Massachusetts Institute of Technology. A grant of $10,000 from the **Monsanto Chemical Co.** will support the project, which will be supervised by a committee of five M.I.T. faculty members: Burnham Kelly of the School of Architecture and Planning, chairman; John E. Arnold of the mechanical engineering department; Albert G. H. Dietz, director of the Plastics Research Laboratory; and Richard Filipowski and Ralph Rapson of the department of architecture. Richard W. Hamilton, research associate in the Albert Farwell Bemis Foundation will act as coordinator.

The following awards have been sponsored by the **National Tuberculosis Association** and its medical section, the American Trudeau Society, during 1953–54.

Grants-in-aid

R. J. Anderson, Sterling Chemistry Laboratory, Yale University. Chemistry of tubercle bacilli.

T. L. Badger, Boston City Hospital. Pulmonary physiology.

E. Bogen, Olive View Sanatorium. Classification of mycobacteria.

V. Bryson, Long Island Biological Laboratory. Genetics of mycobacteria.

P. A. Bunn, State University of New York Medical College.

Use of the rabbit eye as a tissue for study in experimental tuberculosis.

M. I. Bunting, Brady Laboratory, Yale University. Genetics of mycobacteria.

A. Christie, Vanderbilt University School of Medicine. Pulmonary calcification in fungus diseases.

C. Cohen, Jackson Memorial Laboratory. Propagation of rabbit stocks of known resistance to tuberculosis.

S. P. Colowick and N. O. Kapian, McCollum-Pratt Institute, Johns Hopkins University. Mechanism of action of isonicotinic acid hydrazide.

J. E. Forney, University of Southern California Medical School. Allergy and serology of tuberculosis.

B. Gerstl, Veterans Administration Hospital, Oakland, Calif. Humoral antibodies in tuberculosis.

A. Goldman, City of Hope Medical Center. Protein and adrenal function studies in tuberculosis patients.

D. M. Gould, Johns Hopkins Hospital. Production of teaching films on chest diseases.

K. A. Harden, Howard University School of Medicine. Chronic pulmonary disease, lung surgery, and cardiac function.

W. F. Kirchheimer, Northwestern University Medical School. Correlation of mycobacterial enzyme and growth inhibition.

V. E. Krahl, University of Maryland School of Medicine. Structure of mammalian lung.

E. M. Lincoln, New York University—Bellevue Medical Center. Tuberculosis in children.

M. B. Lurie, Henry Phipps Institute, University of Pennsylvania. Genetic resistance to tuberculosis.

W. McDermott, Cornell University Medical College. Host-parasite relationships in tuberculosis.

G. M. Meade and R. S. Mitchell, Trudeau Sanatorium and Foundation. Statistical study of treatment in tuberculosis.

G. Middlebrook, National Jewish Hospital, Denver. Chemotherapy and pathogenesis of experimental tuberculosis.

Q. N. Myrvik, University of Virginia Medical School. Role of tuberculo-inhibitory factors in host resistance to tuberculosis.

C. E. Palmer, Public Health Service, Washington, D.C. Minimal tuberculosis in nurses.

E. M. Papper, Columbia University College of Physicians and Surgeons. Effects of anesthesia during pulmonary resection.

H. Pope, Duke University School of Medicine. Metabolism of tubercle bacilli.

S. Raffel, Stanford University School of Medicine. Immunity and allergy in tuberculosis.

F. B. Seibert, Henry Phipps Institute, University of Pennsylvania. Antigens of the tubercle bacillus.

W. Steenken, Jr., Trudeau Laboratory, Trudeau Sanatorium and Foundation. Maintenance of culture depot.

V. A. Stembridge, University of Texas Medical Branch. Statistical study of pathologically proved tuberculosis.

K. Terplan, University of Buffalo and Laboratories of Niagara Sanatorium. Pathogenesis of tuberculosis and significance of old encapsulated lesions.

A. J. Vorwald, Saranac Laboratory, Trudeau Foundation. Effect of inhaled silica on attenuated tubercle bacilli.

D. N. Walcher, Indiana University Medical Center. Evaluation of streptokinase-streptodornase in tuberculosis meningitis.

C. Weiss, Albert Einstein Medical Center. Caseation and softening in tuberculosis.

H. S. Willis, North Carolina Sanatorium. Vaccination against tuberculosis.

R. J. Winzler, University of Illinois College of Medicine. Mucoproteins in human plasma.

G. W. Wright and G. F. Filley, Trudeau Sanatorium and Foundation. Pulmonary function studies.

National Society for Medical Research, Chicago. Annual contribution to education program on scientific animal experimentation.

Fellowships

A. J. Crowle, Stanford University, with S. Raffel. Immunizing factor of the tubercle bacillus.

D. D. Daniels, University of California, with Ellen Brown. Pulmonary function studies.

A. M. Dannenberg, Jr., University of Utah, with E. L. Smith. Characterization of some of the proteolytic enzymes of animal tissues.

J. E. Hawkins, Duke University, with D. T. Smith and Hilda Pope. Vitamin metabolism of virulent and avirulent strains of the tubercle bacillus.

N. B. Holmgren, Northwestern University, with G. P. Youmans. Metabolism of virulent and avirulent mycobacteria.

O. B. Houglum, University of Washington, with R. S. Weiser. Nature of bacterial surface of mycobacteria in relation to lysozyme resistance.

I. Krasnow, University of California Medical School, with E. Bogen. Physiological behavior of mycobacteria species as an aid in their identification, differentiation, and classification.

E. M. LaFond, Glen Lake Sanatorium, with W. B. Tucker and others. Statistical analysis of clinical aspects of 300 cases of skeletal tuberculosis before advent of streptomycin.

E. M. Sewell, Children's Chest Clinic New York University—Bellevue Medical Center, with Edith M. Lincoln. Therapy of tuberculosis in childhood.

R. H. Shepard, Johns Hopkins University, with Joseph L. Lilienthal. Measure of oxygen tension in whole blood.

H. Wago, New York University, with Vera S. Fry. Attitudes of registered professional nurses toward tuberculosis nursing.

J. W. Whalen, Michigan State College, with W. L. Mallman. Problems in detection and isolation of *M. tuberculosis* in pathological material.

Teaching-resident fellowships

J. P. Biehl, Cincinnati General Hospital.

R. H. Clauss, Bellevue Chest Service.

D. D. Harrell, University of Pennsylvania Graduate Hospital.

M. E. Shafran, Montefiore Hospital, New York.

O. C. Steinmayer, Jr., Albany Hospital.

J. G. Tuttle, Wake Forest College, Bowman Gray School of Medicine.

C. D. Williams, University of Chicago Dept. of Medicine.

In the Laboratories

In response to inquiries concerning the status of Zeiss in Germany, **Carl Zeiss, Inc.**, New York, reports as follows:

The Carl Zeiss factory at Jena was founded in 1846. During 1889 Professor Abbe, then its sole owner, created the Carl Zeiss foundation and turned over all his property to it. When, after World War II, Jena, and that section of Germany, came under the Soviet regime, the new communistic government of East Germany took away all Zeiss property without any compensation, and changed the name of the firm to "Optik Carl Zeiss Veb" (property owned by the People). This sovietization had grave consequences for the industrial organization as well as for the employee-employer relations of Zeiss in the Eastern Zone.

After the conclusion of World War II in 1945, all members of the Board of Management of Carl Zeiss and of the Carl Zeiss foundation, together with many scientists, members of the engineering staff and technical specialists were evacuated from Jena by the United States Army. They were brought to Western Germany in the United States Zone, with permission to start a new Zeiss factory. This was done.

The new Zeiss Works in Oberkochen operated first under the name of "Zeiss Opton." Since October, 1953, it has borne the name "Carl Zeiss." As in former years, it is a part of the Carl Zeiss foundation which is now domiciled in West Germany. All products imported and distributed and sold by Carl Zeiss, Inc., New York, are manufactured in West Germany.

The new **Chemical Products Plant of the Aluminum Company of America** in Bauxite, Ark., is 50 percent complete, with two of the four production units in operation.

Cornell Aeronautical Laboratory, Inc., Buffalo, is building a small transonic-supersonic wind tunnel, valued at over $150,000, for studying the basic prob-

lems of airflow up to speeds about three times that of sound. Only through recent developments have tunnels been able to test in the transonic speed range, as previously a "choking" in airflow would occur at or around the speed of sound. The new tunnel will require 2000 hp for operation and will have a 1-ft² testing area.

Levinthal Electronic Products, Inc., a new organization in Redwood City, Calif., will combine a specialty in electronic medical instruments with research, development, and merchandising of other products relating to the fields of applied physics and electronics.

A $250,000, 60-megavolt microwave linear accelerator, the third operating member of the unique group of radiation devices for the treatment of cancer in the **University of Chicago's Argonne Cancer Research Hospital,** recently produced its first beam of electrons. Physicists will conduct further tests to determine basic characteristics of the beam and thus the accelerator will not be available for patient treatment for several months.

Westinghouse Electric Corp. has broken ground at Blairsville, Pa., for its new metals plant, which is to bridge the gap between research and the commercial application of new metals and alloys in the electrical industry. The expectation is that most of the machinery and equipment will be installed and operating by mid-1955.

In the development and application of new metals, the Blairsville plant will work closely with the new Westinghouse Research Center now under construction about 10 mi east of Pittsburgh; it also will have limited capacity for the manufacture of special metals needed by various Westinghouse operating divisions. The plant will provide equipment for the basic metal working processes of melting, forging, hot-rolling, cold-rolling, conditioning, pickling, and heat-treating. In addition, there will be facilities for new foundry techniques and for limited manufacture of powdered metal parts.

Miscellaneous

The Committee on Disaster Studies of the National Academy of Sciences—National Research Council published its first issue of the ***Disaster Research Newsletter*** in March 1954. Disaster research has needed a medium through which investigators in the field might learn of current disaster research and of other personnel engaged in the study of disaster phenomena. Because of the multi-discipline approach to such study, it is hoped that the *Newsletter* may serve as liaison to investigators in the various scientific, administrative, and organizational fields, and that it will stimulate an exchange of information among investigators.

Individuals or institutions engaged in basic or applied research, the administration or organization pertinent to disaster study, or in the planning or relief of disaster problems, may obtain the *Newsletter* gratis from the Committee on Disaster Studies, 2101 Constitution Ave., Washington 25, D.C.

A new bulletin, ***Forest Cover Types of North America (Exclusive of Mexico),*** has just been published by the Society of American Foresters. The price is $1, postpaid, from the Society office, Mills Building, 17th St. at Pensylvania Ave., NW, Washington 6, D.C. This publication is a revision and combination of previous bulletins and contains detailed descriptions of the forest types of the United States, Canada, and Alaska. These descriptions cover species and associates, composition, occurrence, importance, place of the type in vegetative succession, variants, and synonyms. Two comprehensive tables list common and technical names of the tree species with authority of the new U.S. Forest Service "Check List."An index of forest types is included.

Human Biology, founded in 1929 by the late Raymond Pearl, will be published by the Wayne University Press under the editorship of Gabriel Lasker, the secretary of Section H of the AAAS. This 26-yr-old quarterly is a "record of research" with special emphasis on the biometry of man and the other primates. The first issue under the new management appears this month, and is devoted to studies on man, with particular reference to growth and infant mortality. Of the six original articles in it, three come from abroad—one each from Africa, Asia, and Europe. The September issue will feature the symposium on the nonhuman primates and human evolution that was presented at the Boston meetings of the AAAS last December; it will include an article by the late Earnest A. Hooton of Harvard University and is a memorial to him. Later issues will include articles on human genetics, population trends, and evolutionary theory, with book reviews and brief communications as well.

Besides Dr. Lasker, the editorial board includes Josef Brozek, University of Minnesota; Bentley Glass, The Johns Hopkins University; Donald Mainland, New York University; James N. Spuhler, University of Michigan; and William L. Straus, Jr., of Johns Hopkins.

Human Biology is unusual among scholarly journals in that it is financed entirely by subscriptions. The annual subscription rate continues at $5, a price held constant since the beginning. Subscriptions may be placed with Wayne University Press, Detroit 1, Mich. Manuscripts for consideration should be sent to Dr. Gabriel Lasker, 1401 Rivard St., Detroit 7, Mich.

The **Indian National Scientific Documentation Centre** (INSDOC) is a national nonprofit organization set up by the Government of India in 1952, with the help of UNESCO, to provide all scientific and technical workers in India with a central library and documentation service. The Government of India has not restricted INSDOC in any way from offering its services to other countries on the same terms as to Indian citizens. The address of INSDOC is National Physical Laboratory, Hillside Rd., New Delhi 12.

Book Reviews

Microwave Theory and Techniques. H. J. Reich, H. L. Krauss, P. F. Ordung, J. G. Skalnik. Van Nostrand, New York-London, 1953. 901 pp. Illus. $10.

Microwave Theory and Techniques presents a profusely documented treatment of theory, components, and measurement techniques employed at frequencies extending upward from approximately 300 or 400 magacycles per second. It is chock-full of useful information, of interest not only to students but also to research workers and communication engineers. It is very well suited either as a classroom textbook or as a reference book. The approach is mainly descriptive rather than rigorously mathematical. For each topic, basic relationships are defined, methods of solving the mathematical forms for specific boundary restrictions are outlined, and final conclusions are formulated as equations involving required variables. Appropriate illustrations appear throughout and include graphs and tables.

The first nine chapters are devoted to field and impedance concepts related to propagation and diffraction in transmission systems. Following an introduction to vector analysis, various electromagnetic laws, theorems, and boundary restrictions are developed as applicable to static and dynamic fields. Distributed circuit theory is explained and applied to the steady-state description of transmission lines under the influence of different load conditions in terms of traveling waves. Applications of resonant lines and transmission line charts are emphasized. This is preceded by the representation of guided waves as modes in rectangular, circular, ridge, and surface wave guides. Numerous wave-guide and coaxial line components are described, such as matching devices, transition sections, phase shifters, wave-guide tees, hybrid rings, directional couplers, wave meters, filters, and duplexers. Also included are devices for the measurement of field strength, power, and standing-wave ratio as well as measuring techniques. There is a chapter on broad-band antennas which delineates characteristics and excitation methods. Another chapter treats microwave resonators, exemplified by parallel-wire, coaxial-line, and wave-guide types, and contacting and non-contacting plungers.

The last six chapters are concerned with microwave tubes, amplifiers, and oscillators. The influence of density-modulated beams on equivalent circuits and performance is first considered. This is followed by a discussion of transit-time effects and the manner in which conventional triodes and tetrodes can be improved for applications at microwave frequencies. Special tubes designed for use with coaxial-line and cavity resonators are described. Among them are acorn and doorknob tubes, lighthouse tubes, pencil triodes, closed-spaced triodes, and disk-seal tetrodes. Two comprehensive chapters are devoted to velocity-modulated tubes or klystrons. A chapter on magnetrons treats various types of magnetron principles and their realization into practical arrangements. The last chapter is on traveling-wave and electron-wave tubes. It includes physical principles of operations and examples of designed tubes.

An outline of typical microwave laboratory experiments is described in the final pages. The MKS system of units is used throughout the book. With the exception of one, each chapter has been concluded with an interesting list of problems.

The subject matter is expertly treated. Since the coverage is intended to be broad, certain topics appear to be briefly mentioned. However, this is not a serious drawback since references are available for the reader who is interested in learning more about specific items. The authors are to be complimented for the diligent choice of topics.

ANTHONY B. GIORDANO
Department of Electrical Engineering
Polytechnic Institute of Brooklyn

Australian and New Zealand Botany. John McLuckie and H. S. McKee. Associated General Publ., Sydney, Australia, 1954. xx + 758 pp. Illus. £4 4s.

At first thought it seems odd to have a national botany textbook, but immediately one realizes that British, French or American is usually implicit in the title of botany textbooks. Considering the uniqueness of the Australian and New Zealand flora, it is reasonable that a book should be written for Australian and New Zealand university students which relates the general facts learned about plants from study of those of the Northern Hemisphere to the plants with which they have been familiar since childhood.

McLuckie and McKee's textbook teaches its main lessons from the well-known plants such as bean, sunflower, corn, and *Tradescantia*. Students will be familiar with the anatomical and physiological facts derived from study of these plants when they go on for graduate work at home or in other countries, or when they read research reports based on work with crop or ornamental plants of Europe and North America that are also grown commonly in their own country. In addition, they will be able to see wherein the native plants of their countries are like or unlike those plants.

The chapters on the Australian flora and the New Zealand flora will be most helpful to students in those countries. They will also be valuable to visiting European or American botanists. A great deal of information is in these pages that was unavailable in any one place before. The chapters on the botanical history of the two countries are also very useful and, among other things, remind us that Darwin, Wallace, Huxley, and Hooker were all familiar to some extent with the flora of this part of the world and were undoubtedly influenced in their thinking by this knowledge.

In the more standard parts of a botany textbook,

McLuckie and McKee have done a good job, profusely illustrated with line drawings and diagrams. There are few photographs and the reproduction of some is not up to a standard one would like. One wonders why, and also why some could not have been included to show the ecological types found in the two countries. But the diagrams of cytological and anatomical structures are excellent; the graphs and data in the discussions of physiological processes are clear and meaningful.

Anyone writing or revising an elementary textbook would do well to ponder this book for its organization of topics and for the integration of biochemical and anatomical material. It presumes a knowledge of chemistry and, hence, includes many more advanced discussions of physiology than American introductory textbooks. On the whole, it is clearly written, and rarely can there be doubt in the reader's mind as to what sentences or paragraphs mean. There are remarkably few misstatements or misleading statements that I caught. The emphasis on the physiology of all kinds of plants, especially heterotrophic flowering plants, is most welcome. All in all, McLuckie and McKee have put many people in debt to them for this solid first Australian and New Zealand botany textbook. It will be a valuable addition to the libraries of botany teachers anywhere else in the world for the wealth of information that is in it.

HARRIET B. CREIGHTON
Department of Botany, Wellesley College

Protozoaires: Rhizopodes, Actinopodes, Sporozoaires, Cnidosporidies, vol. 1, pt. II of *Traité de Zoologie: Anatomie, Systématique, Biologie.* Pierre-P. Grassé, Ed. Masson, Paris VI^{e}, 1953. 1160 pp. Illus. Paper, 9035 fr.; cloth, 9215 fr.

With the appearance of this second section of a tripartite treatise on the Protozoa, French biologists have made another signal contribution to their ambitious program of reviewing the phyla of the animal kingdom. The first section dealt with flagellates; the third is to deal with ciliates; the present one covers the intervening groups. It is indeed a far cry from Bütschli's solitary monographic effort (1880–89) to the present treatment, in which nine authorities have collaborated on this single section. Under Grassé's active leadership as editor and coauthor, the Protozoa are being subjected to an extensive reevaluation, group by group. Five subphyla (*sous-embranchement*) are recognized in the *Traité*: Rhizoflagellata, Actinopoda, Sporozoa, Cnidosporidia, and Ciliata. In the present volume, greatest attention will probably be attracted to the rearrangement proposed within the first two of these groups.

The Flagellata (vol. I, fasc. I) and Rhizopoda are established as superclasses of the Rhizoflagellata, in recognition of overlapping affinities and of the polyphyletic derivation of rhizopods from flagellates. The Rhizopoda are separated according to basic pseudopodial types into three classes: Lobosa, Filosa, and Granuloreticulosa. Each of these in turn contains both naked and testate forms. The book opens with Chatton's account of the naked amebas (order Amoebaea). Two distinct groups have been separated: suborder Mastigogenina, possessing flagellate stages in the cycle, and suborder Amastigogenina, exclusively ameboid. In turn, Deflandre has replaced the Testacea of most authors by two orders. The order Testacealobosa (containing most well-known testate amebas) is combined with the Amoebaea to form the class Lobosa, while the remaining forms, bearing filopodia (for example, Euglypha), are placed in the class Filosa. Deflandre also treats the two basal orders (including, for example, Allogromiidae) of the class Reticulogranulosa, while Le Calvez presents a full, authoritative account of the third order, Foraminifera. Cushman's taxonomic system is followed in the interests of expediency, but Le Calvez evaluates it in a critical manner.

The subphylum Actinopoda is subdivided by Trégouboff into three classes: Heliozoa, Acantharia (Actipylean Radiolaria of other systems), and Radiolaria. Evidence is adduced to link the first two of these groups into an evolutionary sequence leading from chrysomonad flagellates, while the independent status of the Radiolaria is emphasized by a suggestion of their dinoflagellate ancestry. In an appendage to the Rhizopoda, Pavillard has presented a relatively brief, informative, and impartial treatment of "doubtful rhizopods or lower fungi": the orders Acrasiae, Myxetozoa, and Plasmodiophorales.

The two remaining subphyla, Sporozoa and Cnidosporidia, have been subjected to more classical treatment. Grassé is responsible for most of the account on Sporozoa. The two principal classes, Gregarinomorpha and Coccidiomorpha, are clearly established as coordinate groups with suggestions of flagellate ancestry. Subgroupings have been modified to form apparently more natural sequences. Grassé chooses to retain the Sarcosporidia as a third class, remaining unconvinced by recent evidence of their fungous affinities. Poisson has written a highly thorough account of the Haemosporidiidea (suborder of Coccidiomorpha), with detailed references to all aspects of the biology of malaria. Poisson is also responsible for the lucid treatment of the Cnidosporidia, without altering the usual arrangement. A few miscellaneous groups of Sporozoa-like organisms are collected in appendiceal chapters; for example, Babesioidea (Poisson), Haplosporidia (Caullery), and certain still more obscurely related types, such as Bartonella, Toxoplasma, Rickettsia, and so forth (Poisson).

The general organization of the book deserves special commendation. Each chapter is introduced with a well-outlined account of the biology of a given group and concludes with a treatment of systematics. There is a complete, up-to-date bibliography at the end of each chapter; the practice of including full titles and pagination of articles cited can be commended to others. The wealth of illustrations is notable for clarity and full documentation of the text; two colored plates,

numerous halftone figures, and some photographs are included. The text seems remarkably free of errors, despite an appendix of *errata* and *addenda*. A detailed table of contents is included at the end of the book, along with an index of 50 double-column pages.

Not all protozoologists will find the systematic treatment and emphasis completely satisfactory. The most difficult problems still reside within the Rhizoflagellata. Chatton's account of the crucially placed Amoebaea (completed after his death by Grassé) seems to suffer from a rather diffuse, less well documented treatment of taxonomic affinities than most other sections, but this group is admittedly difficult to handle. The general emphasis in the work is frankly upon taxonomic and morphologic aspects. Although this organization is not especially fitted to the currently expanding trend toward comparative biochemical and physiological studies on Protozoa, nevertheless a substantial foundation can be assembled from careful selection in the text.

All in all, this section of the *Traité* clearly seems to achieve its major objectives: to organize our current knowledge of these groups of the Protozoa and to indicate future lines of fruitful research.

WILLIAM BALAMUTH

Department of Zoology
University of California, Berkeley

Renal Function. Transactions of the Fourth Conference, 1952. Stanley E. Bradley, Ed. Josiah Macy, Jr. Foundation, New York, 1953. 189 pp. Illus. $3.50.

This report on renal function takes the same form as its well-known predecessors. In addition to an informal discussion of "Ion exchanges between extracellular and intracellular fluids" led by R. F. Pitts, it contains presentations on "Cation exchanges in the renal tubular epithelium" (Mudge), "Ion transport across living membranes" (Ussing), and "Water and ion movements across intestinal and renal epithelium" (Visscher).

As a means of promoting meaningful communication between scientific disciplines, which is a fundamental aim of the conference program, the transactions are probably less useful to the readers than the conference is to the participants. Moreover, the substance of these presentations is no longer new or has been published elsewhere, and the discussions, when read, seem unsatisfyingly diffuse and uneven. In places one finds a spirited, *avant-garde* sort of atmosphere—for example, where a participant vigorously challenges the validity of application of a Donnan-type equilibrium for certain cells—but it dissipates quickly, and one winces at the inclusion of such unregenerate arguments as, "Accuracy is supposed to be one of the virtues of mathematics, and if an equation is found to be inaccurate, I don't see why we keep using it."

This slim volume would have been helped by an index, particularly since many nephrologists will experience a certain obligation to own it. For physiologists at large, however, the report is too specialized and will have limited value. Clinicians, who may be misled by the title, will not acclimate to its rarefied air.

A. V. WOLF

Washington 12, D.C.

British Veterinary Codex 1953. Council of the Pharmaceutical Society of Great Britain. Pharmaceutical Press, London, 1953. 737 pp. 45s. + 1s. postage.

The *British Veterinary Codex*, published under the direction of the Council of the Pharmaceutical Society of Great Britain, sets forth standards for substances and preparations employed in the prophylaxis and treatment of animal diseases, and supplies information on actions and uses of these preparations. The material in it was compiled by the British Veterinary Codex Committee, composed of veterinarians and other interested individuals working in specialized fields of science in Great Britain. In addition, members of the veterinary profession from other countries served as corresponding members of the committee.

These major sections appear: Part I is devoted to monographs that briefly describe the chemical and physical properties, actions, uses, dosage, incompatibilities, and toxicity of drugs and chemicals employed in veterinary medicine. A total of 431 monographs appear. A summary of standards is given for substances that appear in the *British Pharmacopoeia* or in the *British Pharmaceutical Codex*. For agents not listed in these sources, standards prepared by the Veterinary Codex Committee are described. Chemical formulas are in accordance with current practice in Great Britain. Only those agents for which the committee considered there is adequate pharmacological and/or clinical evidence of usefulness and for which adequate standards could be prepared are included. Part II contains similar monographs on antisera, vaccines, and related biological products. Part III lists formulas and describes methods of preparation and standards for therapeutic and prophylactic agents. These monographs are listed according to the type of preparation—boluses, capsules, creams, dusting powders, and so forth. In addition to these major sections, the book contains a therapeutic and pharmacological index, tables of weights and measures, a synonym list, and information on chemical and biological assay methods.

Publication of the *British Veterinary Codex* fills a critical need in veterinary medicine for an authoritative source of information on agents used in the treatment and control of animal disease. All those who participated in this effort are to be congratulated. Perhaps the greatest service rendered by this book is the listing of standards for a number of drugs and biologicals that are widely used in veterinary medicine but for which no such standards appear in other authoritative sources. Veterinarians in the United

States may experience some difficulty with the terminology used for some drugs, but the helpful synonym list should aid in this respect.

JOHN E. MARTIN
Department of Physiology and Pharmacology, School of Veterinary Medicine
University of Pennsylvania

Microwave Lenses. J. Brown. Wiley, New York; Methuen, London, 1953. 125 pp. Illus. + plates. $2.

The subject of this small book is a recent development in microwave technique. The introduction of so-called artificial dielectrics, dating back only a few years, opened new possibilities for designing microwave antenna. The properties of these structures, consisting of conducting elements of various shapes spaced according to some pattern, should be of general interest to a physicist. Such a reader might wish to find in the book more emphasis on this aspect.

The book is intended primarily for those interested in antenna design. The analyses involved are similar to those of geometrical optics. The first two chapters present general considerations and radiation patterns of microwave lenses. The different types of dielectrics are then treated in separate chapters, each beginning with an explanation of the properties of the dielectric followed by discussions of lens design. The use of lenses for wide-angle scanning is taken up in a separate chapter and also enters in the discussions of the last three chapters.

The material covered in the book is well organized. The presentation is clear and concisely covers the essentials of the subject.

H. Y. FAN
Department of Physics, Purdue University

Hydrocarbons from Petroleum. ACS Monograph No. 121. Frederick D. Rossini, Beveridge J. Mair, and Anton J. Strieff. Reinhold, New York, 1953. 556 pp. Illus. + charts. $18.50.

This volume is the result of more than 300 man-years of work performed by the American Petroleum Institute Research Project 6 under the able direction of Frederick D. Rossini. The project was carried out with creative imagination. This document should be a part of every library in the world for its enormous amount of useful information, not alone from the standpoint of research, but also for industrial utility. It is the result of more than 25 years of continuous study that has given us for the first time an intimate and quantitive knowledge of individual hydrocarbons present in a number of crude oils.

The physical properties of the highly purified individual hydrocarbons isolated were analyzed through the very latest techniques available. The purification of these compounds was achieved through the use of a wide number of fractionation processes, including such techniques as low-pressure distillation, thermal diffusion in the gas phase, and electrophoresis. The details of mechanisms of operation and procedures for purification of the individual hydrocarbons are given.

This monumental tome covers not only the fractionation, analysis, isolation, purification, and properties of hydrocarbons but also investigations of sulfur, nitrogen, oxygen, and metallic compounds and fractions of crude oil such as gasoline, kerosene, gas oil, and lubricating oils. In addition, synthetic products, such as alkylates, codimers, and hydrocodimers, were also analyzed in detail with respect to the structure and properties of the individual compounds present.

Hydrocarbons from Petroleum is literally a bible on the subject, packed with information not available before.

The foreword states:

> Fundamental research under the sponsorship of the American Pertoleum Institute had its inception in a grant of $250,000 made by John D. Rockefeller on November 15, 1925, augmented by an equal sum given on January 12, 1926, by Universal Oil Products Company, which provided for a five-year program of research in fields of interest to the petroleum industry.

The program was continued with funds provided by the member companies of the American Petroleum Institute, and the researches are still continuing at the Carnegie Institute of Technology under the direction of Rossini.

GUSTAV EGLOFF
Universal Oil Products Company, Des Plaines, Illinois

New Books

Vapor Pressure of Organic Compounds. T. Earl Jordan. Interscience, New York–London, 1954. ix + 266 pp. Plates. $14.50.

Snow Crystals: Natural and Artifical. Ukchiro Nakaya. Harvard Univ. Press, Cambridge, 1954. xii + 510 pp. Illus. $10.

The Track of Man. Adventures of an anthropologist. Henry Field. Doubleday, Garden City, N.Y., 1953. 448 pp. Plates. $5.95.

Stress Concentration Design Factors. R. E. Peterson. Wiley, New York; Chapman & Hall, London, 1953. 155 pp. Illus. $8.50.

Radio Receiver Design. Pt. 1. Radio frequency amplification and detection. ed. 2. K. R. Sturley. Wiley, New York, 1953. 667 pp. Illus. $10.

A Practical Manual of Medical and Biological Staining Techniques. Edward Gurr. Interscience, New York, 1953. xix + 320 pp. $4.

Organic Chemistry. ed. 2. Reynold C. Fuson and H. R. Snyder. Wiley, New York; Chapman & Hall, London, 1954. viii + 544 pp. Illus. $6.50.

Metabolism of Steroid Hormones. Ralph I. Dorfman and Frank Ungar. Burgess, Minneapolis, 1953. 170 pp. Illus. $4.

International Symposium on Atmospheric Turbulence in the Boundary Layer. Geophysical Research Papers, No. 19. Massachusetts Institute of Technology, June 4–8, 1951. E. W. Hewson, Ed. Geophysics Research Directorate, Air Force Cambridge Research Center, Cambridge, 1952. 530 pp. Illus.

Induction and Dielectric Heating. J. Wesley Cable. Reinhold, New York, 1954. vii + 576 pp. Illus. $12.50.

Graphic Problems in Petroleum Geology. L. W. LeRoy and Julian W. Low. Harper, New York, 1954. ix + 238 pp. Illus. + plate. $4.50.

For a Science of Social Man. Convergences in anthropology, psychology, and sociology. John Gillin, Ed. Macmillan, New York, 1954. 289 pp. $4.

Exploration Hydrobiologique du Lac Tanganika (1946–47) Résultats Scientifiques. Vol. III, Fasc. 5A: *Poissons Non Cichlidae.* Max Poll. Institut Royal des Sciences Naturelles de Belgique, Brussels, 1953. 251 pp. Illus. + plates.

The Biochemistry of the Nucleic Acids. ed. 2. J. N. Davidson. Methuen, London; Wiley, New York, 1953. viii + 200 pp. Illus. + plates. $2.25.

Relaxation Methods. D. N. de G. Allen. McGraw-Hill, New York–London, 1954. ix + 257 pp. Illus. $7.50.

Neuere Probleme der Abstammungslehre. Die transspezifische Evolution. ed. 2. Bernhard Rensch. Ferdinand Enke, Stuttgart, Ger., 1954. 436 pp. Illus. DM 49.20.

How Strong Is Russia? A geographic appraisal. George B. Cressey. Syracuse Univ. Press, Syracuse, N.Y., 1954. ix + 146 pp. Illus. $3.

4000 Years under the Sea. The story of marine archaeology. Philippe Diolé. Trans. by Gerard Hopkins. Messner, New York, 1954. xiv + 237 pp. Illus. $4.50.

An International Bibliography on Atomic Energy. Vol. 2: Scientific Aspects. Supp. No. 2, UN, New York, 1953 (U.S. Distr.: Columbia Univ. Press, New York). vii + 320 pp. $3.50.

Atomic Energy: A Survey. J. Rotblat, Ed. Taylor & Francis, London, 1954 (For the Atomic Scientists' Assoc.). viii + 72 pp. Illus. + plates. Cloth, 6s 6d; paper, 4s 6d.

Know Your Reader. The scientific approach to readability. George R. Klare and Byron Buck. Hermitage House, New York, 1954. 192 pp. $2.95.

Graphics in Engineering and Science. A. S. Levens. Wiley, New York; Chapman & Hall, London, 1954. viii + 696 pp. Illus. $7.

Wine as Food and Medicine. Salvatore P. Lucia Blakiston, New York, 1954. 149 pp. $3.

General Psychology. ed. 4. Douglas H. Fryer, Edwin R. Henry, and Charles P. Sparks, Barnes & Noble, New York, 1954. xix + 300 pp. Illus. Paper, $1.50.

American Seashells. R. Tucker Abbott. Van Nostrand, New York, 1954. xiv + 541 pp. Illus. + plates. $12.50.

Geschichte der Mathematik. J. E. Hofmann. Walter de Gruyter, Berlin, 1953. 200 pp. DM 2.40.

The Cultivation of Animal and Plant Cells. Philip R. White. Ronald Press, New York, 1954. xi + 239 pp. Illus. $6.

Physical Geology. L. Don Leet and Sheldon Judson. Prentice-Hall, New York, 1954. ix + 466 pp. Illus. $6.75.

A Laboratory Manual of Vertebrate Embryology. ed. 3. F. B. Adamstone and Waldo Shumway. Wiley, New York, 1954. vi + 98 pp. Illus. $2.50.

Electronics. An electrical engineering approach. George F. Corcoran and Henry W. Price. Wiley, New York; Chapman & Hall, London, 1954. x + 459 pp. Illus. $7.

Introduction to Vertebrate Embryology. ed. 5. Waldo Shumway and F. B. Adamstone. Wiley, New York; Chapman & Hall, London, 1954. x + 389 pp. Illus. $6.

Engineers' Dreams. Willy Ley. Viking Press, New York, 1954. 239 pp. Illus. $3.50.

Physics and Applications of Secondary Electron Emission. H. Bruining. McGraw-Hill, New York: Pergamon Press, London, 1954. xii + 178 pp. Illus. $5.

Vector and Tensor Analysis. G. E. Hay. Dover, New York, 1953. viii + 193 pp. Illus. Cloth, $2.75; paper, $1.50.

The Origins of Psycho-analysis. Letters to Wilhelm Fliess, drafts and notes: 1887–1902. Sigmund Freud. Marie Bonaparte, Ann Freud, and Ernst Kris, Eds. Trans. by Eric Mosbacher and James Strachey. Basic Books, New York, 1954. xi + 486 pp. $6.75.

The Challenge of Our Times. Contemporary trends in science and human affairs as seen by 20 professors at the Univ. of Wisconsin. Farrington Daniels and Thomas M. Smith, Eds. Burgess, Minneapolis, 1953. viii + 364 pp. $3.50.

The Freshwater Fishes. Vol. I. Eng. ed. 1. Key to game and commercial fishes of the Prov. of Quebec. Vianney Legendre. Quebec Biological Bur., Montreal, 1954. 180 pp. *Les Poissons d'Eau Douce,* Vol. I. Fr. ed. 2.

Petrography. An introduction to the study of rocks in thin sections. Howel Williams, Francis J. Turner, and Charles M. Gilbert. W. H. Freeman, San Francisco, 1954. x + 406 pp. Illus. $6.50.

Proceedings of the Ankara Symposium on Arid Zone Hydrology. UNESCO, Paris, 1953 268 pp. Illus.

Traité de Pisciculture. ed. 2. Marcel Huet. Éditions La Vie Rustique, Brussels, 1953. xii + 371 pp. Illus.

Country Doctor. Cornelius Wilson Larison, 1837–1910. Harry B. Weiss. New Jersey Agric. Soc., Trenton, 1953. 235 pp. Illus. Paper, $2.50.

The Vitamins: Chemistry, Physiology, Pathology. Vol. I. W. H. Sebrell, Jr. and Robert S. Harris, Eds. Academic Press, New York, 1954. xiii + 676 pp. Illus. $16.50.

Essays in Experimental Logic. John Dewey. Dover, New York, 1953 (Reprint of 1903 ed.). 444 pp. Cloth, $3.50; paper, $1.75.

Transactions of the Symposium on Fluid Mechanics and Computing. Sponsored by the American Mathematical Soc. and Office of Ordnance Res., U.S. Army. Garrett Birkhoff, K. O. Friedrichs, and T. E. Sterne, Eds. Interscience, New York–London, 1954. 243 pp. Illus. $5.

The Fundamentals of College Chemistry. ed. 2. G. Brooks King and William E. Caldwell. American Book, New York, 1954. viii + 589 pp. Illus. $4.50.

A First Year of College Mathematics. ed. 2. Raymond W. Brink. Appleton-Century-Crofts, New York, 1954. xvi + 725 pp. Illus. $5.

Essays in Sociological Theory. Rev. ed. Talcott Parsons. Free Press, Glencoe, Ill., 1954. 459 pp. $6.

Thomas Young, Natural Philosopher: 1773–1829. The late Alexander Wood; completed by Frank Oldham. Cambridge Univ. Press, New York, 1954. xx + 355 pp. Illus. + plates. $6.

Concerning the Nature of Things. Sir William Bragg. Dover, New York, 1954 (Reprint of 1948 ed.). xi + 231 pp. Illus. + plates. Cloth, $2.75; paper, $1.25.

The Social Function of Art. Radhakamal Mukerjee. Philosophical Library, New York, 1954. xxii + 280 pp. + index + plates. $10.

Crystal Data. Classification of substances by space groups and their identification from cell dimensions. Geological Soc. of America Mem. 60. J. D. H. Donnay and Werner Nowacki. Geological Society, New York, 1954. ix + 719 pp.

Lubrication of Industrial and Marine Machinery. ed. 2. The late William Gordon Forbes; rev. by C. L. Pope and W. T. Everitt. Wiley, New York; Chapman & Hall, London, 1954. viii + 351 pp. Illus. $6.50.

Chemistry of the Defect Solid State. A. L. G. Rees. Methuen, London; Wiley, New York, 1954. viii + 136 pp. Illus. $2.

Miscellaneous Publications

Maryland Poultry Reference Book. Maryland State Poultry Council, 1954. 100 pp. Illus.

Plant Genera, Their Nature and Definition. *Chronica Botanica*, vol. 14, No. 3. A symposium. G. H. M. Lawrence *et al.* Chronica Botanica Co., Waltham, Mass., 1953. 70 pp. Illus. $2.

Proceedings of the Society for the Study of Fertility. No. 5. W. Heffer & Sons, Cambridge, Eng., 1953. 105 pp. Illus. + plates. 10s.

Transactions of Eighteenth Annual Meeting. Bull. No. 26. Industrial Hygiene Foundation of America, Pittsburgh 13, 1953. 87 pp. Illus. $1.50.

Pure and Applied Science and Their Appropriate Forms of Organization. Pamph. No. 14. Michael Polanyi. 13 pp. 1s. 3d. ***Freedom and Authority in Scientific Publication.*** Pamph. No. 15. John R. Baker. 14 pp. 1s. 3d. Soc. for Freedom in Science, Oxford, Eng., 1953.

Reheating Refractories of Interest to Australian Gas Suppliers. Div. of Industrial Chemistry Tech. Paper No. 1. J. Coutts and W. O. Williamson. Commonwealth Scientific and Industrial Res. Organization, Melbourne, Australia, 1951. 22 pp.

Agronomic Studies of Vetches and Other Large-seed Legumes in Southern Western Australia. Div. of Plant Industry Tech. Paper No. 1. E. T. Bailey. Commonwealth Scientific and Industrial Res. Organization, Melbourne, Australia, 1952. 21 pp.

Strong-Carter Dental Clinic Annual Report 33 (through August, 1953). Strong-Carter Dental Clinic, Honolulu 17. 48 pp. Illus.

Sixth Annual Report of the Director (April 1952–March 1953). Fishing Industry Res. Inst., Cape Town, South Africa. 27 pp.

La Mesure de la Pression Atmosphérique. Contrib. No. 8. R. Sneyers. 11 pp. Illus. ***A Propos du "Ras de Marée" du 1er février 1953.*** Contrib. No. 10. L. Poncelet. 4 pp. ***La Tempête et le Débordement de la mer du 1er février 1953.*** Contrib. No. 11. R. Sneyers. 12 pp. Illus. Institut Royal Météorologique de Belgique, Uccle-Bruxelles, 1953.

Primer Catalogo General de Colecciones Micologicas Latino Americanas. Centro de Cooperacion Cientifica de la Unesco Para America Latina, Montevideo, Uruguay, 1952. 71 pp.

Survey of Neurobiology. Pub. 237. National Academy of Sciences, National Res. Council, Washington, 1952. 40 pp.

Graded Bedding, with Observations on Lower Paleozoic Rocks of Britain. Ph. H. Kuenen. North-Holland Pub. Co., Amsterdam, 1953. 47 pp. Illus. + plates.

Some Conservation Problems of the Great Lakes. Biol. Notes No. 31. Harlow B. Mills. 14 pp. Illus. ***Some Facts about Illinois Snakes and Their Control.*** Biol. Notes No. 32. Philip W. Smith. 8 pp. Illus. ***A New Technique in Control of the House Fly.*** Biol. Notes No. 33. Willis N. Bruce. 8 pp. Illus. Authority of the State of Illinois, Urbana, 1953.

Sedimentation in Cold Springs Reservoir, Umatilla County, Oregon. SCS-TP-117. Elliott M. Flaxman. U.S. Dept. of Agriculture, Soil Conservation Service, Washington 25, 1953. 26 pp. Illus.

Curran Point, Larne, County Antrim: The Type Site of the Irish Mesolithic. Proc. of the Royal Irish Acad., vol. 56, sec. C, No. 1. Hallam L. Movius, Jr. Royal Irish Acad., Dublin, 1953. 195 pp. Illus. + plates. 25s.

Quatrième Rapport Annuel. Institut pour la Recherche Scientifique en Afrique Centrale, rue Montoyer, 42, Bruxelles, 1951. 227 pp. Illus. + plates.

California Cooperative Oceanic Fisheries Investigations Progress Report. State Fisheries Lab., Terminal Island, Calif., 1953. 44 pp. Illus.

Systematic Study of the Algae of Sewage Oxidation Ponds. SWPCB Pub. No. 7. State Water Pollution Control Board, Sacramento, Calif., 1953. 35 pp. Illus.

Fire and the Atomic Bomb. Fire Res. Bull. No. 1. D. I. Lawson. Dept. of Scientific and Industrial Res. London, 1954. 30 pp. Illus. 65¢.

The Mentally Subnormal Child. Tech. Rpt. Ser., No. 75. 46 pp. 25¢. ***Expert Committee on Environmental Sanitation, Third Report.*** No. 77. 25 pp. 25¢. ***Expert Committee on Rheumatic Diseases, First Report.*** No. 78. 25 pp. 25¢. ***Expert Committee on Rabies, Second Report.*** No. 82. 27 pp. 25¢. ***Treponematoses: A World Problem.*** vol. 8, No. 2–3. 77 pp. Illus. 50¢. ***The Work of WHO, 1953.*** Official records of the World Health Organization, No. 51. 190 pp. Illus. $1.50. World Health Organization, Geneva, 1954.

Fresh-Water Limestone from the Torola Valley, Northeastern El Salvador. Fieldiana, vol. 10, No. 16. Sharat Kumar Roy and Robert Kriss Wyant. 1953. 19 pp. Illus. 50¢. ***Amphibians and Reptiles of Yemen.*** vol. 34, No. 24. Karl P. Schmidt. 1953. 9 pp. Illus. 15¢. ***Some Mammals of Yemen and Their Ectoparasites.*** vol. 34, No. 23. Colin Campbell Sanborn and Harry Hoogstraal. 1953. 23 pp. 35¢. ***Social Feeding Behavior of Birds.*** Fieldiana, vol. 36, No. 1. Austin L. Rand. 1954. 71 pp. Illus. $1. Chicago Natural History Museum, Chicago.

Refrigeration Research Foundation Report of the Director, 1953. Refrigeration Res. Foundation, Colorado Springs, 1954. 36 pp.

Action du Rayonnement Solaire dans la Haute Atmosphère. Contrib. No. 7. M. Nicolet. 1952. 53 pp. Illus. ***Transformation du Système de Contrôle du Chauffage du Frigorimètre de Davos en Vue d'Assurer une Constance Suffisante de la Température de la Sphère.*** Publications Serie B, No. 10. R. Dogniaux and W. Vandenborre. 1953. 11 pp. Illus. Institut Royal Meteorologique de Belgique, Uccle-Bruxelles.

Louis Auguste Deschamps. Historical Ser., vol. I, No. 2. C. G. G. J. Van Steenis, M. J. Van Steenis-Kruseman, and C. A. Backer. 19 pp. + plate. 6s. ***Some Upper Cretaceous and Eocene Fruits from Egypt.*** Geology, vol. 2, No. 4. M. E. J. Chandler. 40 pp. Illus. + plates. 16s. ***Early Literature on Mallophaga.*** (Pt. III). Entomology, vol. 3, No. 6. Theresa Clay and G. H. E. Hopkins. 45 pp. Illus. + plates. 10s. ***Miocene Hyracoids of East Africa.*** Fossil mammals of Africa, No. 7. T. Whitworth. 58 pp. Illus. + plates. £1. 5s. British Museum (Natural History), London, 1954.

Tests on Prestressed Concrete Beam. Trans. of the Japan Soc. of Civil Engineers, No. 17 (In Japanese). Shunji Inomata. Japan Soc. of Civil Engineers, Tokyo, 1953. 89 pp. Illus.

Chronic Illness, Digests of Selected References, 1950–52. Public Health Bibliog. Ser. No. 1 Supp. U.S. Dept. of Health, Education, and Welfare, Washington 25, 1954. 262 pp. $1.

Alameda County Mosquito Abatement District Annual Report, 1953. Alameda County Mosquito Abatement Dist., Oakland 7, Calif. 17 pp. Illus.

Nutrition Research Laboratories Annual Report for 1952–53. Nutrition Res. Laboratories, Coonoor, South India, 1953. 39 pp.

Technical Papers

Mast Cells in Human Atherosclerosis

A. Cairns and P. Constantinides

Department of Anatomy,
University of British Columbia, Vancouver, Canada

The observation that in some mammals there is an inverse correlation between tissue mast cell content and susceptibility to alimentary lipemia, or atherosclerosis (*1*), prompted a quantitative study of mast cells in human hearts (*2*).

Mast cells were counted in toluidine blue-stained 7 μ paraffin sections from the formalin-fixed myocardium of 46 young adults (20 to 35 yr old) without any evidence of atherosclerosis, 48 senile adults (60 to 90 yr old) with marked generalized atherosclerosis, and 48 senile adults (60 to 90 yr old) without gross evidence of atherosclerosis. The three groups were evenly divided in males and females.

The counts were made without knowledge of the identity of the samples. Two hundred high-power fields, covering an actual myocardium area of 8 mm², were counted in every sample. It should be noted that the occasional infarcts or scars were excluded from the counting and that mast cells were counted only in pure cardiac muscle tissue. The results, expressed as average number of mast cells (± standard error ε) per square centimeter myocardium, are presented in Tables 1 and 2.

Table 1 shows that (i) atherosclerotic seniles had a lower count than nonatherosclerotic young adults ($p = < 0.001$); (ii) there was no significant difference between the counts of nonatherosclerotic seniles and nonatherosclerotic young adults ($p = 0.5 - 0.4$); (iii) senile atherosclerotics had a lower count than senile nonatherosclerotics ($p = 0.02 - 0.01$).

Table 2 reveals that (i) among the nonatherosclerotic young adults, the males had a lower count than the females ($p = 0.02 - 0.01$); (ii) among the females, atherosclerotic seniles had a lower count than nonatherosclerotic young adults ($p = < 0.001$); (iii) among the females, there was no significant difference between the counts of nonatherosclerotic seniles and nonatherosclerotic young adults ($p = 0.2 - 0.1$); (iv) although the male counts followed the female pattern, there were no significant differences between them.

Table 1. Heart mast cell counts of mixed male-female groups.

No. of individuals per group	Group	No. of mast cells/cm² myocardium ± ε	*p*
46	I. Young adults	297 ± 18.2	I vs. II: < 0.001
48	II. Senile atherosclerotic	198 ± 20.8	I vs. III: 0.5 – 0.4
48	III. Senile nonatherosclerotic	273 ± 23.9	II vs. III: 0.02 – 0.01

Table 2. Heart mast cell counts of male and female groups.

No. of individuals per group	Group	No. of mast cells/cm² myocardium ± ε	*p*
23	I. Female young adults	351 ± 30.1	I vs. II: 0.02 – 0.01
23	II. Male young adults	239 ± 33.1	I vs. III: < 0.001
24	III. Female senile atherosclerotic	193 ± 28.5	I vs. V: 0.2 – 0.1
24	IV. Male senile atherosclerotic	201 ± 30.7	
24	V. Female senile nonatherosclerotic	276 ± 33.5	
24	VI. Male senile nonatherosclerotic	270 ± 34.9	

The high statistical significance of the difference between the counts of nonatherosclerotic young adults and atherosclerotic seniles (mixed or female) is remarkable if it is taken into consideration that the groups under comparison were very heterogeneous. These groups consisted of individuals who died from a great variety of diseases of diverse duration and severity (acute and chronic infections, tumors, endocrine-metabolic disorders, poisons, and so forth). The only common features of each group were the presence or absence of atherosclerosis, the sex, and, within very broad limits, the age. Since there are indications that tissue mast cell concentrations can be influenced by adrenal and other hormones (*3–5*), it is possible that variable conditions of endocrine imbalance prevailing in each individual accounted for part

of the count variation within each group. More homogeneous groups could thus be expected to present smaller standard errors and greater intergroup differences.

The interpretation of these findings will have to await further morphological and biochemical studies.

References and Notes

1. P. Constantinides, *Science* **117**, 505 (1953).
2. This study was supported by the National Research Council of Canada. The cooperation of the pathology department of the University of British Columbia in providing human tissues is gratefully acknowledged.
3. G. Asboe-Hansen, *Scand. J. Clin. Lab. Invest.* **2**, 271 (1950).
4. C. Cavallero and C. Braccini, *Proc. Soc. Exptl. Biol. and Med.* **73**, 141 (1951).
5. P. Constantinides and J. Rutherdale, *Proc. 67th Ann. Meeting Am. Assoc. Anat.*, Apr. 1954, in press.

10 March 1954.

Sulfide Inhibition of Catalase

Roland F. Beers, Jr.,* and Irwin W. Sizer

Department of Biology, Massachusetts Institute of Technology, Cambridge, Massachusetts

Current investigations on the mechanism of inhibition of catalase by anions (*1*) have revealed several phenomena peculiar to sodium sulfide inhibition of catalase. In view of the recent report by Boeri and Bonnischen (*2*) of the oxidation of thiol groups by catalase, we are presenting these preliminary findings in advance of the general work on anion inhibition (*3*). Sulfide exhibits two distinct kinds of inhibition. The first, typical of monovalent anions such as acetate and chloride, appears to occur only in the presence of the substrate; the second occurs in its absence and is actually reversed by the substrate.

In these studies, the rate of destruction of hydrogen peroxide (Merck), initial concentration approximately $10^{-2}M$, by crystallized beef liver catalase (Worthington) was followed spectrophotometrically by the method previously described (*4*). The reaction mixture was maintained at *p*H 7.0 with 0.01*M* phosphate buffer at 25°C. The concentration of the uninhibited enzyme at any time *t* was determined graphically from the tangents of the semi-log slope of the optical density of H_2O_2 versus time curve (*5*).

If sodium sulfide is added simultaneously with the substrate to the catalase solution, the initial inhibition is slight or absent, but during catalysis the enzyme is rapidly inhibited in a manner identical to that found with acetate and chloride (Fig. 1, upper curve). In contrast, if sodium sulfide is added to the catalase solution before the substrate, the initial inhibition is appreciable, and its magnitude increases slowly with the incubation time (5 to 15 min) allowed before the substrate is added. This inhibition appears to occur at a much slower rate than that observed when peroxide is present and is proportional to the hydrogen ion and sulfide concentrations. However, this inhibition is partially reversed during the catalysis of hydrogen peroxide (Fig. 1, middle and lower curves). It is also reversed to a small degree by bubbling nitrogen and to a greater degree by bubbling oxygen through the catalase and sodium sulfide solution. This represents a true reactivation of the enzyme and not a destruction of the substrate through a stoichiometric reaction with the sulfide, because (i) the initial rate, when the sulfide concentration is the highest, is the slowest rate, and (ii) the concentration of the hydrogen peroxide is approximately 10^4 times greater than that of the sulfide (*6*). By choosing the proper concentration of sulfide and time of contact with the enzyme before adding the substrate, it is possible to obtain inhibition curves intermediate between the extremes shown in the figure.

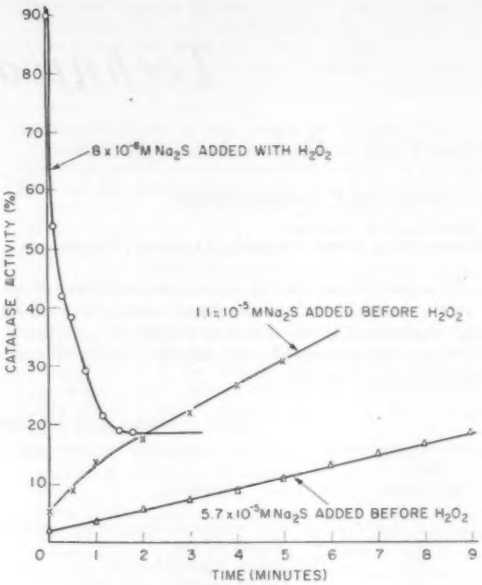

CATALASE ACTIVITY (%)
TIME (MINUTES)
8 x 10⁻⁶M Na₂S ADDED WITH H₂O₂
1.1x10⁻⁵MNa₂S ADDED BEFORE H₂O₂
5.7x10⁻⁵MNa₂S ADDED BEFORE H₂O₂

Fig. 1. Change in activity of catalase during the catalysis of hydrogen peroxide (initial concentration $10^{-2}M$). (Upper curve) Sulfide and peroxide added simultaneously to the catalase solution. (Lower curves) Sulfide and catalase incubated together for 10 min before the addition of peroxide.

During the course of these inhibition studies, we have observed that the oxidation of sodium sulfide to colloidal sulfur (*p*H 7.0) is accelerated by catalase in the presence or absence of peroxide. This oxidation is manifest by the appearance at the surface of the reaction mixture of a cloudy area of colloidal sulfur, which rapidly extends downward as oxygen mixes with the system. Since, in all probability, the enzyme is refractory to hydrogen peroxide under these conditions, it is very probable that the mechanism for oxidation of sulfide is a nonspecific phenomenon asso-

* Present address, Division of Physical Biochemistry, Naval Medical Research Institute, National Naval Medical Center, Bethesda, Maryland.

ciated with the iron of the heme groups or, as suggested by Boeri and Bonnischen for the oxidation of thiol group (*2*), may be a new property of the catalase molecule unrelated to the catalytic properties heretofore ascribed to it. A few preliminary studies of the absorption curve of the protein moiety at the end of the reaction show a rather marked increase at 2800 A. As yet we have not been able to rule out an artifact as a possible cause of this increase.

It appears that sulfide may inhibit catalase in two ways. First, it may form an inactive compound with the primary catalase-peroxide complex in a manner similar to that postulated for monovalent anions (*1, 7*). Second, it may react directly with either the protein moiety or with the heme. Both processes are reversible to a degree depending on the experimental conditions.

References and Notes

1. R. F. Beers, Jr., and I. W. Sizer, In preparation.
2. E. Boeri and R. K. Bonnischen, *Acta Chem. Scand.* **6**, 968 (1952).
3. This work was done under an American Cancer Society Fellowship recommended by the Committee on Growth of the National Research Council.
4. R. F. Beers, Jr., and I. W. Sizer, *J. Biol. Chem.* **195**, 133 (1952).
5. ———, *Science* **117**, 710 (1953).
6. Controls indicate that under these conditions peroxide is not broken down by the sodium sulfide.
7. R. F. Beers, Jr., Ph.D. thesis, Massachusetts Institute of Technology (1951).

10 February 1954.

The Role of Magnesium in Photosynthesis

Leonard S. Levitt

Department of Chemistry,
Stevens Institute of Technology, Hoboken, New Jersey

The obvious connection between the presence of an Fe atom and the oxidation-reduction properties of certain biologically important porphyrin compounds, such as the heme pigments, catalase, and the cytochromes, has long been recognized, whereas, in the important phenomenon of photosynthesis, which also is an oxidation-reduction process, the presence of the Mg atom and its role in the reaction has been overlooked, if not studiously ignored.

From the simple fact that the Mg-containing molecules of chlorophyll *a* and *b* are effective in photosynthesis, whereas the Mg-free pheophytins are without effect, it is apparent that the Mg atom plays an important, and indeed, an indispensable role in the process. It might be thought that the presence of Mg merely endows the chlorophyll molecule with the particular absorption spectrum which is the peculiar requisite for the energy requirements of photosynthesis, and that other than this, the Mg atom takes no direct part in the reaction. That such is not the case may be seen from the fact that pheophytin has an absorption spectrum quite similar in many respects to that of the chlorophylls, and yet is inert in photosynthesis (*1*). It may be concluded that the Mg atom is inexorably bound up with the entire phenomenon, as well as with the chlorophyll molecule.

According to the photoelectric theory of photosynthesis (*2*), in which it is postulated that light-activated chlorophyll transfers electrons to an oxidant (presumably, the disulfide group of pyruvic oxidase (*3*), which will be abbreviated $\overline{S—R—S}$) and abstracts electrons from water, it is believed that the chlorophyll might be converted intermediately to a positively charged ionic species, representing an oxidized state. Direct evidence in support of this thesis will now be presented; and in addition, it will be shown that the specific micro-site of the positive charge is at the Mg atom.

In the ground state the chlorophyll molecule contains Mg covalently linked to any two of the four pyrrole nitrogen atoms. From the standpoint of resonance the Mg atom may be thought of as linked simultaneously by one-half a covalent bond to each of the four N atoms. Extreme forms in which the Mg and N atoms have, respectively, one or more positive and negative formal charges and vice-versa, also contribute, undoubtedly, to the resonance hybrid; but on the whole the Mg atom may be considered neutral. It is here postulated that in photosynthesis it is this essentially neutral Mg atom which absorbs the photon with resultant activation of one of its 3*s* electrons to a higher energy state:

$$\text{Chl–Mg} + h\nu \rightarrow \text{Chl–Mg.}^* \qquad (1a)$$

Subsequent loss of the excited electron to the weak oxidant results in formation of oxidized chlorophyll, characterized by unipositive Mg:

$$\text{Chl–Mg}^* + \overline{\text{S—R—S}} \rightarrow \text{Chl–Mg}^+ + \cdot\text{S—R—S}:^- \qquad (1b)$$

Alternatively, it would appear that absorption of a quantum of sufficiently high energy could result in the immediate ejection of a photoelectron and its direct capture by the oxidant:

$$\text{Chl–Mg} + h\nu \rightarrow \text{Chl–Mg}^+ + e^-, \qquad (2a)$$

$$\overline{\text{S—R—S}} + e^- \rightarrow \cdot\text{S—R—S}:^- \qquad (2b)$$

In either case (Eqs. 1 and 2), positively ionized chlorophyll should result, and it may be supposed that during active photosynthesis in ordinary sunlight, the bombardment of chlorophyll by photons is of such intensity as to produce and maintain a considerable concentration of the unipositive oxidized form. If an oxidized chlorophyll molecule should fail to recapture an electron from a water molecule before being struck by a second photon, its remaining 3*s* electron may, presumably, absorb the energy of the incident photon and be excited to a higher quantum level, and then be removed by the oxidant (*4*). Such a sequence may be represented by

$$\text{Chl–Mg}^+ + h\nu \rightarrow \text{Chl–Mg}^{+*}, \qquad (3a)$$

$$\text{Chl–Mg}^{+*} + \cdot\text{S—R—S}:^- \rightarrow \text{Chl–Mg}^{++} + :\text{S—R—S}:^- \qquad (3b)$$

which would be followed immediately by

$$\text{Chl–Mg}^{++} + \text{H}_2\text{O} \rightarrow \text{Chl–Mg} + 2\text{H}^+ + \tfrac{1}{2}\,\text{O}_2. \qquad (3c)$$

Only extremely small amounts of the dipositive oxi-

Table 1. Comparison of visible absorption bands* of ether solutions of chlorophyll with emission lines of Mg^0 and Mg^+. Wavelengths are in millicrons. Principal bands of the chlorophylls are in italics.

Mg^0	Mg^+	Chl *a*	Chl *b*	Chl *c*
	655	*660*	655†‡	
	635	613	*642*	*635*§
			594	
553		574	567	
			553	
			540	
517		530		
		511		
501		498	501	
457		464	457	
	448		*452*	*450*
	439	440‡		
435		*430*	435‡	
			428	
406		409		

* Complete bibliography available in Rabinowitch (*6*), pp. 606, 668, 736, 801, 826.
† Fluorescence value.
‡ *In vivo.*
§ Value for both absorption and fluorescence.

dized chlorophyll could be expected from a process such as the one represented by Eqs. 3, and any further electronic excitation of this species would be improbable kinetically because of its low concentration, and quite impossible energetically because of the unavailability of sufficiently short wavelengths in white light to effect activation of the $2p$ or $2s$ electrons of Mg^{++}.

In view of the foregoing considerations one might expect, to some extent at least, a correspondence of certain of the absorption and fluorescence bands of the chlorophylls with the emission spectra of electronically excited states of the Mg^0 atom (according to Eq. 1*a*), and of the Mg^+ ion (according to Eq. 3*a*), but not of the Mg^{++} ion.

In Table 1 are presented, for purposes of comparison, all of the usually observed lines of the visible emission spectra (400 to 700 mμ) of Mg^0 and Mg^+ (*5*) together with all of the absorption maxima of chlorophylls *a*, *b* and *c* in the visible range (*6*).

It is immediately apparent that there is almost a complete line-for-line correspondence of the chlorophylls with magnesium. In view of the many factors which could be expected, in as complicated a structure as chlorophyll, to distort and mask the spectrum due to magnesium, it can hardly be denied that the agreement is little short of remarkable. That the correspondence is not just fortuitous can be ascertained from the fact that for other singly ionized metallic atoms closely related to Mg^+ there is an almost universal noncorrespondence with the chlorophyll lines. For example, among the other rare earth elements and other third period metals, Na^+ and Sr^+ exhibit a complete absence of lines in the visible range; Ca^+ has only two lines (at 422 and 408 mμ); Ba^+ has 18 (with none above 598 mμ); and Al^+ has some 24 (from 624 to 400 mμ), few of which correspond to those of chlorophyll. A further correlation is obtained if the spectral range under consideration be extended to the ultraviolet region. Table 2 gives all of the known ultraviolet absorption peaks (*6*) of chlorophylls *a* and *b*, and the corresponding emission lines (*5*) of Mg^0 and Mg^+.

Table 2. Comparison of ultraviolet absorption bands of chlorophyll and magnesium. Wavelengths in millimicrons.

Mg^0	Mg^+	Chl *a*	Chl *b*
384	385	375	
334			335
323		325	
309	310		310
	245	250	250

Additional evidence that the Mg atom is directly involved in the primary photochemical process is the fact that all Mg-containing porphyrins and phthalocyanins can be oxidized much more readily than is the case when Mg is absent from the molecule (*7*).

Even more conclusive is the fact that "photochemically oxidized" chlorophyll has an absorption spectrum identical with that of pheophytin (*7*). This shows unequivocally that it is the Mg atom, and it alone, which is oxidized in this process. It seems evident from the foregoing facts that the site of photochemical reaction is at the Mg atom of chlorophyll, and it would appear that excited electronic states of both Mg^0 and Mg^+ (*8*) are involved (the lowest excited state of Mg^{++} is far in the ultraviolet, and as previously explained, would not be expected to appear). The rather startling conclusion may be reached that the Mg atom in chlorophyll is bound in such a manner as to be nearly equivalent to the free atom in the elemental state, at least insofar as its electronic excitation energies are concerned.

The expulsion of a photoelectron by Chl–Mg (Eq. 2*a*) apparently would require energy equivalent to the first ionization potential of Mg, which is 7.61 v. This corresponds in energy to an incident photon of wavelength 162 mμ, which is far in the ultraviolet and hence not available ordinarily for photosynthesis. Thus, the process represented by Eq. 2 can be ruled out, leaving us with schemes 1 and 3. It is important to note that five of the six principal lines of the visible spectra of the three chlorophylls (Table 1) correspond to the Mg^+ ion. This fact at once suggests that electronic excitation of Chl-Mg^+ (Eq. 3*a*) is a process of considerable importance in photosynthesis. From the spectroscopic data available, then, we may surmise that Eqs. 1, followed by Eqs. 3, comprise the main sequence of reactions taking place.

An interesting fact which remains to be explained is the similarity of the absorption spectrum of Mg-free pheophytin to that of the chlorophylls. We may speculate that the pheophytin molecule was evolved (*9, 10*) in such a fashion as to specifically accommodate, and simulate as closely as possible, the electronic excitation characteristics of the Mg atom. In this way,

the entire molecule is in "energy resonance" with the Mg atom (that is, in resonance with nearly the same wavelengths), thus effectively increasing many fold the cross-sectional area for absorption of a photon. A rapid shift of electrons to or from the Mg atom is greatly facilitated by the many resonance forms (in the ordinary chemical sense) of which the conjugated bond system is capable, and it may be supposed that these factors, too, are important in photosynthesis.

References and Notes

1. When Mg is introduced into a *phorbin* to produce a *phyllin*, the principal red absorption maximum is increased, and the subsidiary green peaks are weakened. [A. Stern and F. Pruckner, *Z. physik. Chem.* **A185**, 140 (1939)].
2. L. S. Levitt, *Science* **118**, 696 (1953).
3. M. Calvin and J. A. Barltrop, *J. Am. Chem. Soc.* **74**, 6153 (1952); M. Calvin, *Chem. Eng. News* **31**, 1622, 1735 (1953).
4. The absorption of a second successive quantum *before* the loss of the energy of the first (Chl–Mg^{*} + $h\nu$ → Chl–Mg^{**}) is considered quite improbable, as it would demand an extremely long half-life for the first excited state, and would place energy level restrictions on the second excitation.
5. C. D. Hodgman, *Handbook of Chemistry and Physics* (Chemical Rubber Publ., Cleveland, 1952), p. 2314.
6. E. I. Rabinowitch, *Photosynthesis and Related Processes* (Interscience Publishers, New York, 1951), pp. 606, 603–825.
7. V. B. Evstigneev and V. A. Gavrilova, *Doklady Akad. Nauk S.S.S.R.* **74**, 781 (1950).
8. Since this paper was first submitted for publication, direct evidence for the transient existence of Mg^{+} ion in aqueous solution has been obtained by R. L. Petty, A. W. Davidson and J. Kleinberg, *J. Am. Chem. Soc.* **76**, 363 (1954).
9. N. H. Horowitz, *Proc. Natl. Acad. Sci. U.S.* **31**, 153 (1945).
10. S. Granick, *Chem. Eng. News* **31**, 748 (1953).

14 April 1954.

Desoxyribose Nucleic Acid in the Symbiotic Microorganisms of the Cockroach, *Blattella germanica*

M. T. M. Rizki*

Department of Zoology,
Dartmouth College, Hanover, New Hampshire

The existence of intracellular microorganisms in insects has recently been questioned on the basis of negative staining results with the Feulgen reaction and acid-Giemsa technique (*1, 2*). A further objection raised by Lanham is the failure of many investigators to cultivate the symbiotes *in vitro*. Peklo (*3*) and Trager (*4*) have responded to the latter objection, reviewing cases of successful cultivation as well as experimental evidence favoring the reality of these intracellular particles as microorganisms. The occurrence of symbiotes in cockroaches is well known (*5*). Glaser (*6, 7*) claimed isolation of bacterial symbiotes from *Periplaneta americana* and *Blattella germanica* and named them *Corynebacterium periplanetae* and *C. blattellae*, respectively. Gier (*8, 9*), who investigated the distribution of these symbiotes during the life-

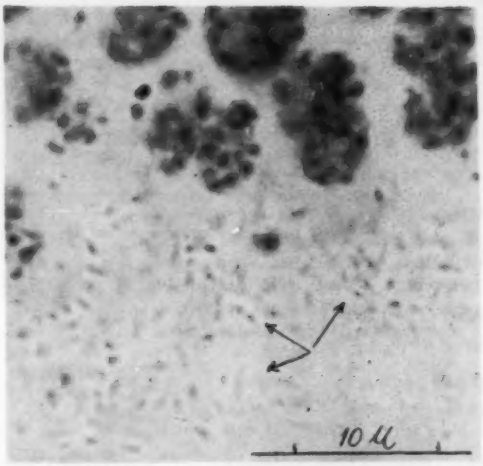


Fig. 1. Photomicrograph of a tangential section of a developing oocyte showing the Feulgen-stained symbiotes and the nuclei of the follicle cells.

cycle of the cockroach, reported failure of cultivation *in vitro*. More recently Keller (*10*) has cultured symbiotes of *Periplaneta orientalis*.

The Feulgen reaction is specific for desoxyribose nucleic acid (DNA) and has been used extensively for the cytochemical demonstration of DNA in plant and animal nuclei. The intracellular symbiotes of cockroaches are Feulgen-positive; therefore, the conclusion of Lanham that symbiotes lack DNA (based on a study of microorganisms of aphids) cannot be extended to other cases.

The Feulgen-positive symbiotes in the mycetocytes and ovaries of cockroaches (two species) were first observed 4 yr ago. The fixative used at that time was Sanfelice. To reexamine this problem, ovaries and fat-bodies of adults and various ages of embryos of *B. germanica* were fixed in Carnoy (3 absolute alcohol: 1 acetic acid) and paraffin sections were cut at 4 to 6 μ. Feulgen stain was prepared and used according to Stowell's method (*11*). A preliminary hydrolysis of sections in 1*N* HCl at 60°C for 1 to 24 min revealed optimal staining of the microorganisms with the Feulgen reagent at 8 to 10 min (Fig. 1); however, both the follicle cells of the developing oocytes and the symbiotes remain unstained in unhydrolyzed control sections. The microorganisms in the mycetocytes and at the periphery of the oocytes are rod-shaped (approximately 1 by 3 μ), as described by Glaser and Gier. The banded appearance of the microorganisms as reported by these authors has been observed in Feulgen-stained material, but these bands are visible in unstained preparations as well. It is difficult to localize the Feulgen-positive material to any particular region of these rods.

For further confirmation of the specificity of the Feulgen reaction for DNA in the microorganisms, sections of embryos and ovaries were treated with des-

* R. Melville Cramer fellow.

Table 1. Effect of various treatments on the Feulgen staining of symbiotes and nuclei of follicle cells.*

1st treatment	2nd treatment	Feulgen reaction	
		Follicle nuclei	Symbiotes
None	DNAse	−	+
	DNAse control	+	+
1*N* HCl at 60°C; 10 min	DNAse	−	+
	DNAse control	+	+
RNAse; 0.2 mg/ml; 56°C for 2 hr	DNAse	−	+
	DNAse control	+	+
	None	+	+
RNAse control	None	+	+
Saliva; 30 min; room temp.	DNAse	−	+
	DNAse control	+	+
2X crystalline pepsin; 2.0 mg/ml in 0.02*N* HCl; 37°C; 45 min	DNAse	−	−
	DNAse control	+	+
	None	+	+
Pepsin controls	None	+	+

* DNAse: 0.1 mg/ml in phosphate buffer *p*H 7.5 with gelatin and magnesium sulfate at room temperature for 45 min.
Controls: same conditions as respective enzyme solutions except absence of the enzyme.
DNAse and RNAse obtained from the Worthington Biochemical Laboratory, Freehold, N.J.; pepsin obtained from the Nutritional Biochemical Corp., Cleveland, Ohio.

oxyribonuclease (DNAse) (*12*). A concentration of 0.1 mg/ml of DNAse in phosphate buffer completely removed all Feulgen-positive material from the nuclei of the follicle cells and other cockroach tissues within 30 min, but the symbiotes remained Feulgen-positive even after 4 hr exposure to the enzyme. To eliminate the possibility of interfering substances staining with Feulgen, free aldehydes and acetals were blocked by hydroxylamine (*13*). The results indicate that the staining of the microorganisms is not due to either of these groups.

Perhaps the failure of DNAse to remove the Feulgen-positive material is a result of the inaccessibility of the DNA which is protected or masked in some way by other cellular constituents. This possibility has been explored by pretreatment of sections with ribonuclease (RNAse) (*14*), acid hydrolysis, saliva and pepsin followed by DNAse. These experiments and the results are summarized in Table 1. The resistance of the DNA of the microorganisms to DNAse was unaffected by predigestion with RNAse, saliva, and acid hydrolysis. However, pretreatment of sections with 2.0 mg/ml of pepsin for 45 min at 37°C was sufficient to allow removal of the Feulgen-positive material from the microorganisms by DNAse. Sections in the DNAse control solution (that is, the same solution and conditions minus the enzyme) and sections in the pepsin control were hydrolyzed and stained simultaneously with the DNAse-treated slides. The nuclei of the follicle cells were considered the control for the activity of DNAse and the other enzymes and reagents.

In conclusion, the symbiotic microorganisms of the cockroach contain DNA as revealed by the Feulgen reaction. Unlike the nuclei of the cockroach tissues the DNA of the symbiotes in the oocytes and mycetocytes is resistant to digestion by DNAse without previous exposure to the proteolytic enzyme pepsin.

References

1. U. N. Lanham, *Science* **115**, 459 (1952).
2. ———, *ibid.* **116**, 332 (1952).
3. J. Peklo, *Science* **118**, 202 (1953).
4. W. Trager, *Science* **116**, 332 (1952).
5. E. A. Steinhaus, *Principles of Insect Pathology*. (McGraw-Hill, New York, 1949).
6. R. W. Glaser, *J. Exptl. Med.* **51**, 59 (1930).
7. ———, *ibid.* 903.
8. H. T. Gier, *Biol. Bull.* **71**, 433 (1936).
9. ———, *J. Bact.* **53**, 173 (1946).
10. H. Keller, *Z. Naturf. Tubingen* **5b**, 269 (1950).
11. R. E. Stowell, *Stain Technol.* **20**, 45 (1945).
12. M. McCarty, *J. Gen. Physiol.* **29**, 123 (1946).
13. A. G. E. Pearse, *Histochemistry* (Little, Brown, Boston, (1953).
14. B. P. Kaufmann *et al., Carnegie Inst. Wash. Yr. Bk.* **46**, 136 (1947).

27 January 1954.

A Fungus Disease in Clam and Oyster Larvae

H. C. Davis, V. L. Loosanoff, W. H. Weston, and C. Martin

U.S. Fish and Wildlife Service, Milford, Connecticut, and The Biological Laboratories, Harvard University, Cambridge, Massachusetts

The improved method for growing lamellibranch larvae developed at the U.S. Fish and Wildlife Service laboratory, Milford, Conn., has offered many new possibilities and approaches for studying the behavior and physiological and ecological requirements of these organisms (*1, 2*). Using this method, the larvae of more than 15 species have been successfully cultured through metamorphosis at our laboratory. Of these, however, the larvae of the common clam, *Venus mercenaria*, and of the American oyster, *Crassostrea virginica*, have been most widely studied (*3, 4*).

Clam larvae are especially suitable for experimental work, and usually their cultures are carried through metamorphosis without experiencing undue difficulties. On several occasions, however, some cultures of an experimental series would show a heavy mortality unrelated to the experimental treatment. Recently, while examining such a culture of clam larvae, Davis noticed an organism, which was tentatively identified as a fungus, in many of the dying and dead larvae. Loosanoff and Davis later observed the same or a related fungus in larvae of *C. virginica*, *Venus mortoni*, and the hybrids of *V. mortoni* ♀ crossed with *V. mercenaria* ♂ and *V. mercenaria* ♀ crossed with *V. mortoni* ♂.

The presence of fungus in our larval cultures appears to be of endemic nature. Usually there are only

a few infected larvae in many of the cultures, yet only in rare instances does the disease acquire epidemic proportions, involving the majority of the larvae, and within 2 to 4 days killing almost the entire population.

During the outbreak of the epidemic, many larvae may be observed in various stages of disintegration, with the fungus quite apparent in their interior. Usually several species of flagellates and ciliates invade the dead or dying larvae to feed upon their tissues, leaving, within a short time, empty shells with practically no traces of the fungus. Even in the cultures in which mortality is especially severe, there usually are some larvae that live through the epidemic without contracting the disease, which suggests the possibility that they may be immune to the fungus.

Larvae of all ages, from the very early free-swimming stage to those ready to metamorphose, have been seen parasitized by the fungus. Individuals that had already metamorphosed into juvenile clams have also been found heavily infested on several occasions, and release of zoospores from the fungus in such animals was observed.

At present we do not know the optimum temperature or salinity for the growth of the fungus or the limits it can withstand. Thus far, the larval cultures in which the fungus infection was noticed have been kept within a temperature range of 19.0 to 27.0°C and in a salinity of about 27.0 parts per thousand. Nor do we know whether some infected larvae may survive the infection, recover from it, and later proceed with normal development. It seems, however, that the majority of the larvae stop growing and die soon after they become infected.

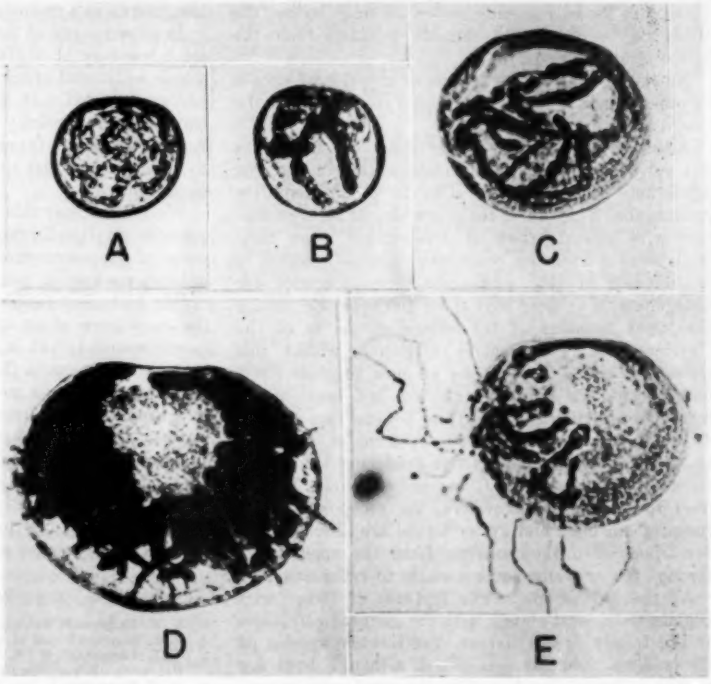


Fig. 1. Larvae infested with fungus. *A* and *B*, young oyster larvae; *C*, young clam larva; *D*, old clam larva; *E*, young clam larva. Larvae *A*, *B*, *C*, and *E* are stained with neutral red, larva *D*, with cotton blue (×224).

The fungus is transmitted by zoospores which emerge through the tip of the exit tube that the sporangium puts forth to the exterior of the infected larva. The zoospores are released in an intermittent stream from these openings, and for a short time they are seen swarming near the edges of the shells of the larvae from which they were released but soon disperse through the water. Theoretically, densely crowded larval cultures should present a better opportunity for development of fungus epidemics than field conditions, because of the proximity of the larvae to one another and, hence, the difficulty of their escaping infection by the large numbers of zoospores swarming about in the water.

Even in this preliminary phase of our investigations, we find that the nature and development of the fungi responsible for this destructive disease show certain distinctive and significant features. Within the larvae, the fungus develops as a contorted, looped, and sparsely branched thallus of torulose character with constrictions at intervals between the swollen and often lobed segments. In both oyster and clam larvae, the thallus may be limited in extent, occupying a relatively small part of the shell cavity, so that its form and structure can be readily seen (Fig. 1*A*, *B*, *C*).

In contrast, in many of the specimens of invaded clam larvae examined, there is much more extensive growth, the fungus occupying a large proportion of the shell cavity with its lobes or segments so densely crowded together in a radiate arrangement that the details of thallus organization cannot be discerned with certainty (Fig. 1*D*). It has not yet been determined whether this difference in thallus character indicates that the simpler, less extensive growth represents a younger phase which will later develop into the more elaborate one or signifies that two different species of fungi are concerned.

As the fungus rapidly develops, the segments mature into sporangia, each with an exit tube extending to the exterior, as can be seen in Fig. 1*D*. The zoospores, already fully developed, emerge through these tubes into the surrounding water. In some larvae, the tubes may protrude considerable distances from the larval shells (Fig. 1*E*).

No sexual stage of the fungus or any resting spores or other resistant entities have been seen in any of the many specimens examined.

Although the identity of the fungi concerned has not yet been specifically determined, their taxonomic affiliations are sufficiently clear to permit tentative designation. Since their thalli are simple in organization with limited extent of development, since their walls show a weak but conclusive cellulose reaction to chloroiodide of zinc, and since their zoospores are biflagellate, it is clear that these fungi belong among the lower members of the biflagellate series of the Phycomycetes. For generic affiliation within this series, the genus *Lagenidium* at once suggests itself both because the looped, contorted, and torulose nature of the thallus is similar and because one species, *Lagenidium calinectes*, is known to occur in salt water and to cause similar destructive epidemics among the larvae of the blue crab in Chesapeake Bay (*5*). In contrast to *Lagenidium*, however, the zoospores in the fungi of our clam and oyster larvae are already fully developed when they emerge from the sporangium through the exit tube and are ready to swim away.

All the critical distinctive features of these fungi affiliate them most closely with the genus *Sirolpidium* of the family Sirolpidiaceae. Yet the two species of *Sirolpidium* thus far recognized, although both are marine and parasitic, have been reported only on such algae as Bryopsis and Ceramium and have never been found on animal hosts. Therefore, the indications are that the fungi attacking the larvae of clams and oysters probably represent one or perhaps even two new species.

It was shown by Loosanoff that the fungus acquires a deeper stain than larval tissues if living larvae are kept in a solution of neutral red in sea water. Thus, this stain can aid in detecting the first appearance of the fungus, and also, by "tagging" the infected larvae, we can study the progress of the epidemics, the percentage of survival of fungus-affected individuals, and other pertinent features. Neutral red may also prove valuable in staining mass samples of natural plankton for easier examination and for determining whether some of the organisms constituting it are infested with the fungus. The usual cotton blue lactophenol technique can also be used to demonstrate presence of the fungus in preserved samples.

In experiments at the U.S. Fish and Wildlife Service laboratory at Milford, we are attempting to find which additional species of lamellibranch larvae may become infected with the fungus disease. At the same time, we are carefully examining the internal condition of the larvae found in our field plankton samples to ascertain whether the fungus occurs under natural conditions.

We believe that this is the first report of a fungus parasite in lamellibranch larvae. Since only a few cases of the occurrence of parasitic fungi in marine animals are known, this discovery should be of considerable biological interest. The possibility exists that the occurrence of an epidemic of this fungus among lamellibranch larvae in nature may seriously affect the sequence of events in the food chain. It is also possible that if we develop a method for control of the fungus under hatchery conditions, a problem on which we are working at present, the artificial cultivation of clams, *Venus mercenaria*, and other mollusks may be rendered commercially feasible.

We wish to express our thanks to our colleague, C. A. Nomejko, for preparation of the photograph that accompanies this article.

References

1. V. L. Loosanoff, *Science* **102**, 124 (1945).
2. V. L. Loosanoff and H. C. Davis, *Biol. Bull.* **98**, 60 (1950).
3. V. L. Loosanoff, W. S. Miller, and P. B. Smith, *J. Marine Research* (Sears Foundation) **10**, 59 (1951).
4. H. C. Davis, *Biol. Bull.* **104**, 334 (1953).
5. J. N. Couch, *J. Elisha Mitchell Sci. Soc.* **58**, 158 (1942).

1 March 1954.

Communications

Fatty Acid Absorption and Chylomicrons

Singer, Sporn, and Necheles [*Science* **118**, 723 (1953)] state: "The absorption pathway of long-chain fatty acids is still controversial." The evidence they cite, however, indicates that some misunderstanding may still persist with regard to the exact nature of the issues involved.

The objective of my original experiments (*1*) quoted by Singer *et al.* was to see whether differences could be detected between the absorption of olive oil on the one hand, and the absorption of its contained fatty acids on the other, since at that time it was generally maintained (*2*) that glycerides could be absorbed only after complete hydrolysis to fatty acids and glycerol. Several differences were found, and as a result of this and many other experimental studies, we concluded that the basic concept of the lipolytic hypothesis—that is, the necessity for complete hydrolysis—was incorrect. Our view that lipolysis need only be partial during absorption has since been amply confirmed (*3*, *4*) by the use of isotope-labeled fats.

As early as 1946 (*5*), I pointed out that the partition of lipid molecules between the water and the oil phase might determine the mode and pathway of absorption. Thus, long-chain fatty acids were difficult to remove from the oil into the water phase under the conditions prevailing in the upper intestine. They thus passed into the body in the particulate fat in the chyle and caused an increase in the number of chylomicrons in the systemic blood; in the absence of carrier glyceride, saturated long-chain fatty acids were poorly absorbed. Shorter chain fatty acids, on the other hand, were more easily removed into the water phase and were not found in the chyle. It was thought that they might pass with other water-soluble substances in the portal blood. Thus it was concluded that saturated fatty acids were partitioned between the oil and water phases according to chain length and water solubility, and that this differential distribution affected their absorption.

This "partition hypothesis" has been completely confirmed by the studies of Chaikoff and his colleagues, using isotope-labeled fatty acids (*6–8*). It was unfortunate that these workers stated in their first paper (*6*) that their observations on the absorption of stearic acid in corn oil were contrary to the partition hypothesis and that this factual misstatement has been repeated by other authors (*9–11*). So far as I am concerned, there is not, and has never been, any controversy with regard to the pathway of absorption of saturated fatty acids; they behave precisely as predicted on the basis of the partition hypothesis (*12*).

The absorption of unsaturated fatty acids is more complicated. Consideration of my original data (*1*) shows that oleic acid could behave in two different ways. If it was fed as a glyceride ester fine intraluminar emulsification occurred and the oleic acid passed mainly in particulate form in the chyle glycerides. When free oleic acid was fed alone however, no intraluminar emulsification was observed, and there was no evidence of particulate absorption during the course of the experiment, although significant amounts of oleic acid were absorbed. Under different circumstances, however, oleic acid may be finely emulsified in the intestinal lumen, and if this should occur, particulate absorption of oleic acid alone might result.

Reiser (*13*), Tidwell (*14*), and Singer *et al.* claimed that their experiments on unsaturated fatty acid absorption do not agree with mine; they are different from mine, both in design and objective. Particulate absorption appears to be occurring in their experiments, but it was not observed in mine. A more precise definition of the intraluminar conditions in the experiments of Reiser, Tidwell, and Singer *et al.* might be interesting.

Unsaturated fatty acids, especially oleic acid, are normally eaten as constituent fatty acids of most dietary glycerides, and they pass largely with the oil phase. We still do not know what happens under abnormal conditions of defective particulate absorption. These are the aspects of the problem with which my studies have been concerned, and they do not necessarily conflict with the observations quoted by Singer, Sporn, and Necheles, the objective of which has been to study fatty acid absorption itself, with which the partition hypothesis—a concept of the mechanism of absorption of dietary glycerides—is only secondarily concerned.

A. C. Frazer

The Medical School, Hospitals Centre
Birmingham, England

References

1. A. C. Frazer, *J. Physiol.* **102**, 306 (1943).
2. W. R. Bloor, *The Biochemistry of the Fatty Acids* (Reinhold, New York, 1943).
3. P. Favarger, R. A. Collet, and E. Cherbuliez, *Helv. Chim. Acta* **34**, 1641 (1951).
4. R. Reiser *et al.*, *J. Biol. Chem* **194**, 131 (1952).
5. A. C. Frazer, *Physiol. Rev.* **26**, 103 (1946).
6. B. Bloom *et al.*, *J. Biol. Chem.* **184**, 1 (1950).
7. B. Bloom, I. L. Chaikoff, and W. O. Reinhardt, *Am. J. Physiol* **166**, 451 (1951).
8. T. Y. Kiyasu, B. Bloom, and I. L. Chaikoff, *J. Biol. Chem.* **199**, 415 (1953).
9. B. Borgström, *Acta Chem. Scand.* **5**, 643 (1951).
10. C. M. Wilhelmj, *Ann. Rev. Physiol.* **14**, 177 (1952).
11. K. Lang, *Die Medizinische* **1**, 10 (1953).
12. A. C. Frazer, *Biochem. Soc. Symposia No. 9* (1952).
13. R. Reiser, *Proc. Soc. Exp. Biol. Med.* **74**, 666 (1950).
14. H. C. Tidwell, *J. Biol. Chem.* **182**, 405 (1950).

10 February 1954.

We do not doubt the general truth of the partition hypothesis of fat absorption, but the results of some of our experiments may modify it.

When oleic acid was introduced into a Thiry loop of intestine, fine, intraluminar emulisification *did* oc-

cur, although bile and pancreatic juice were *not* present. Furthermore the oleic acid disappeared from the loop, and an abundant chylomicronemia gave evidence of its particulate absorption (*1, 2*).

The Thiry loop often contained traces of excreted fat. However, with the large amounts of fatty acid that we used, we consider that, essentially, there was only a water phase, and that carrier fats and glycerides were not available for the degree of absorption that we have observed. The degree of chylomicronemia in the experiments with oleic acid introduced into the Thiry loop sometimes was equal to that observed following the oral feeding of 0.5 g/kg of body weight of olive oil. Therefore, in our experiments, the pathway of absorption of long-chain fatty acid was not determined by either oil phase or glyceride carriers; that is, the fatty acid did *not* behave precisely as predicted on the basis of the partition hypothesis.

In analyzing physiological phenomena, we believe that, in the first place, a simple experiment must be performed, narrowing down the latitude of the experimental conditions to as few factors as possible. Therefore, we have not considered whether fatty acids are normally eaten by the rat as "constituent fatty acid of most dietary glycerides."

"A more precise definition of the intraluminar conditions" in our Thiry fistulas would not help in our opinion, to explain or to shake the doubtless absorption of long-chain fatty acid as chylomicrons from a loop devoid of bile, pancreatic juice, glyceride carriers, or oil phase.

Our experiments on absorption of fatty acid *per se* are a minor point in the investigation of fat absorption in general but our scope was the investigation of basic physiological phenomena.

H. Singer
J. Sporn
H. Necheles
Department of Gastro-Intestinal Research
Medical Research Institute
Michael Reese Hospital, Chicago

References

1. H. Singer, J. Sporn, and H. Necheles, *Science* **118**, 723 (1953).
2. ———, *Gastroenterol.* **26**, 299 (1954).

16 April 1954.

Effect of Elemental Sulfur in the Diet on Load-Extension Hysteresis in Single Wool Fibers

As has already been demonstrated by means of radioactive sulfur as a tracer, sulfur in the diet of sheep is metabolized and appears in wool after a period of 2 wk or less. It has been of great interest, therefore, to discover whether variations in the amounts of sulfur could be correlated with measurable differences in the structure or physical properties of wool. The x-ray diffraction patterns of wool are characteristic of α-keratin but are so diffuse that very slight structural changes are difficult to detect even with the most precise techniques and measurements. There is some slight indication of sharpening of the fiber interferences with increasing amounts of silver in the diet.

Wool samples were secured from sheep of the same age and breed, at the same time. Their basal ration, fed *ad libitum*, contained 0.05 percent sulfur. The only variable was the addition to this standard diet of 0 to 0.7 percent of powdered sulfur, the actual amounts added being 0, 0.20, 0.25, 0.40, 0.55, 0.60, and 0.70 percent. By all odds, the most sensitive method of evaluation of any effects has been the careful determination of elongation of single fibers as a function of applied load. A special, very sensitive piece of apparatus was constructed from an analytic balance such that analytic weights could be added in steps. As the load was applied to the single fibers, an elongation was quantitatively measured by a long pointer and a magnified scale. Enough individual measurements were made of single fibers of each type to assure statistical soundess at constant temperatures and humidity. Remarkable reproducibility has been found in the stress-strain curve, both with loading and with removal of the weights.

For wool with no additional sulfur in the diet, there is very nearly perfect recovery, so that the loop of tension and relaxation is extremely narrow. However, the area measured by a planimeter for wool corresponding to 0.7 percent sulfur in the diet is more than 3 times that of the loop for 0.2 percent sulfur. The intermediate percentages of sulfur also give intermediate values for the hysteresis loop areas.

It is clear, therefore, that sulfur has been metabolized and added to the disulfide linkages between the keratin molecules in the wool fibers. As the number of these bridges statistically placed between molecules increases, there is a greater tendency to retention of the extended configuration of the fiber and resistance to relaxation upon removal of the load. These highly quantitative experiments by a well-known and traditional technique have demonstrated, therefore, the correlation between sulfur in the diet and sulfur in the wool fibers, and the results point clearly to the fact that there should actually be quantitative differences in mechanical behavior of the wool fibers in textiles as a function of the number of disulfide linkages and in terms of metabolism of sulfur in the diet of sheep.

Detailed descriptions of the apparatus and the hysteresis loops will be published elsewhere.

We are indebted to U. S. Garrigus, of the Department of Animal Science, University of Illinois, for his interest and for the wool samples resulting from the feeding experiments in his department.

G. L. Clark
V. E. Buhrke
Department of Chemistry and Chemical Engineering
University of Illinois, Urbana

7 May 1954.

What General Electric People Are Saying...

E. KEONJIAN

Formerly an electronics scientist in Leningrad, Mr. Keonjian is now with the Electronics Division

". . . There is considerable progress in science, particularly in applied fields, such as electronics, in Russia. There are several reasons for it.

First, the Soviet Government encourages development of applied science in every field which has any prospects of being useful for military purposes.

Second, in the atmosphere of strong political pressure and frequent "purges" in which every individual lives, in Russia and in satellite countries, many people regard applied sciences as relatively "safe subjects" that often do not follow all the changes and zigzags of the Communist Party line, as in the case of social science. Consequently, more people devote themselves to applied sciences rather than to any other sciences or activities.

Third, the Soviet scientists have to study the foreign languages more intensely than we do here. They watch very closely all foreign scientific and technical developments and make more efficient use of them than we do.

Fourth, the Soviet Government has complete control over the school system in Russia. It determines their programs, number of students, and their assignments after graduation.

Fifth, unlike the Western world, the Soviet Government is able, without any limitation, to concentrate the selected man power of the country, as well as the full effort of its technology, in few selected fields which it regards vital for increase of military potential.

There is a prevailing opinion among the Western scientists that we strongly underestimate the Soviet science. With few exceptions this is, however, not true. The Western scientists should always remember that in parallel with some real achievements, there is still a considerable amount of propaganda, outward manifestation, and even charlatanry in most of the Soviet claims in science, and the tragic disgrace of Prof. Lysenko's "achievements" in Soviet genetics is not without parallel in other sciences behind the Iron Curtain.

at the IRE, Pennsylvania Section

F. K. McCUNE

Mr. McCune is General Manager, Atomic Products Division

". . . We at General Electric believe that electric companies will be owning and operating a number of atomic power plants within the next ten years.

We believe some of these will be full-scale and, what is most important, they will generate electricity at competitive costs, possibly within five, certainly within ten, years.

We believe that this will be accomplished without Government subsidy for production plant construction or operation, and that Government-supplied fuel will be priced at cost-of-production levels.

We believe that two nuclear reactors best suited for earliest and most effective competition with conventional fuel plants in this country are (a) the light water-moderated and cooled boiling reactor, and (b) the graphite-moderated water-cooled reactor. These we think hold greatest promise in the years just ahead.

In saying these production plants will operate without Government subsidy, I do not wish to detract from the immeasurable significance of knowledge developed through A.E.C. contracts. Of course, the Government's large expenditures for research and development of plutonium production reactors, mobile power reactors, and other power reactors form the base from which private industry can proceed. But, the important thing here is that we believe production size atomic power plants can be made economic. They will stand on their own feet. They may sell products to the Government. They will certainly buy nuclear fuel from the Government. But, trading with the Government need not be a subsidy.

Atomic Industrial Forum Panel
Washington, D. C.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Outstanding

McGRAW-HILL BOOKS

HUMAN PHYSIOLOGY. New second edition

By BERNARDO A. HOUSSAY, JUAN T. LEWIS, OSCAR ORIAS, EDUARDO BRAUN-MENENDEZ, ENRIQUE HUG, VIRGILIO G. FOGLIA, and LUIS F. LELOIR, all Medical Doctors. Translated by JUAN T. LEWIS, M.D. and OLIVE THOMAS LEWIS. In press

This is the new second edition of an internationally acclaimed text presenting all the aspects of human physiology in both their chemical and physical relationships. Nobel Prize winner Dr. Houssay, and his associates, have made extensive modifications and additions to their original work which incorporate the latest data in the field. The chapters on electrical activity of the heart, digestion, carbohydrate metabolism, the physiology of the senses, and the nervous system have been entirely recast. The discussion of the nervous system includes recent advances in the mechanism of conduction of the nerve impulse and synaptic transmission. New knowledge has also been added to the chapters on cellular respiration, vitamins, blood-clotting, the kidney, and sexual physiology and reproduction.

HEALTH FOR EFFECTIVE LIVING: A Basic Health Education Text for College Students

By EDWARD B. JOHNS and WILFRED C. SUTTON, University of California at Los Angeles, and LLOYD E. WEBSTER, Los Angeles County Schools. 490 pages, $4.75

This practical new volume is designed to assist people in achieving the improvement of health behavior for more effective living. The authors depart from the traditional dichotomy of personal and community health, believing that personal, family, and community health interact as the individual makes his life adjustments. Emphasis is on intelligent action rather than on memorization of facts.

HUMAN LIMBS AND THEIR SUBSTITUTES

Edited by PAUL E. KLOPSTEG, Ph.D.; and PHILIP D. WILSON, M.D. 714 pages, $12.00

As the natural leader of the rehabilitation team, the physician will find in this book a comprehensive discussion of all the latest aspects of amputee care. The work represents the coordinated effort of 32 authorities sponsored by the National Research Council.

Send for copies on approval

McGRAW-HILL BOOK COMPANY, Inc.

330 West 42nd Street • New York 36, N. Y.

Meetings & Conferences

August

1–2. Linguistic Soc. of America, Chicago, Ill. (A. A. Hill, 1719 Massachusetts Ave., NW, Washington 6, D.C.)

3–13. Pan American Federation of Engineering Societies, 3rd, São Paulo, Brazil. (H. Pegado, Edificio Maua, Viaduto Dona Paulina, São Paulo.)

9–15. International Cong. of Philosophy, São Paulo, Brazil. (M. Reale, Rua 24 de Maio 104–8, São Paulo.)

9–27. Summer Seminar in Statistics, 5th, Storrs, Conn. (G. Beall, Dept. of Statistics, Univ. of Connecticut, Storrs.)

10–14. Canadian Teachers' Federation, annual, Vancouver, Canada. (G. G. Croskery, 444 Mac Laren St., Ottawa.)

12–14. International Cong. on Group Psychotherapy, 1st, Toronto, Can. (J. L. Moreno, 101 Park Ave., New York 17.)

13–14. International Cong. on Child Psychiatry, Toronto, Can. (A. Z. Barhash, 186 Clinton Ave., Newark 5, N.J.)

13–21. World Poultry Cong., 10th, Edinburgh, Scotland. (Cong. Sec., Dept. of Agriculture for Scotland, St. Andrew's House, Edinburgh 1.)

14–21. International Cong. on Mental Health, 5th, Toronto, Can. (J. D. Griffin, 111 St. George St., Toronto 6.)

15–28. Pan Indian Ocean Science Cong., Perth, Western Australia. (A. D. Ross, 31 Ventnor Ave., West Perth.)

16–18. American Malacological Union, Durham, N.H. (M. Teskey, 144 Harlem Ave., Buffalo 24.)

18. Stanford Conf. on Population Problems of Latin America, Stanford, Calif. (R. Hilton, Hispanic American Studies, Stanford Univ., Stanford.)

19–20. National Council of Geography Teachers, San Francisco, Calif. (Mrs. I. C. Robertson, State Teachers College, Valley City, N.D.)

19–31. International Conf. of Ship Hydrodynamics, 7th, Göteborg, Sweden. (H. F. Nordstrom, Statens Skeppsprovningsanstalt, Göteborg.)

20–26. American Pharmaceutical Assoc., Boston, Mass. (R. P. Fischelis, 2215 Constitution Ave., NW, Washington 7, D.C.)

23–26. American Veterinary Medical Assoc., annual, Seattle, Wash. (J. G. Hardenbergh, 600 S. Michigan Ave., Chicago 5, Ill.)

23–28. International Cong. for the Philosophy of Science, 2nd, Zurich, Switzerland. (Sec., Internationales Forum Zurich, Room 20d, Eidengenssische Hochschule, Zurich 6.)

23–28. International Cong. of Soil Science, 5th, Leopoldville, Belgian Congo. (F. A. van Baren, Royal Tropical Inst., Mauritskade 63, Amsterdam, Netherlands.)

23–28. International Photobiological Cong., Amsterdam, Netherlands. (Cong. Sec., Radiologische Laboratorium, Wilhelminagasthuis, Amsterdam.)

23–3. International Scientific Radio Union, 11th, The Hague, Netherlands. (I. E. Herbays, 42 Rue des Minimes, Brussels, Belgium.)

24–28. Potato Assoc. of America, Estes Park, Colo. (R. L. Hougas, Dept. of Genetics, Univ. of Wisconsin, Madison 6.)

25–27. American Phytopathological Soc., annual, Estes Park, Colo. (G. S. Pound, Dept. of Plant Pathology, Univ. of Wisconsin, Madison.)

(See the June 18th issue for more comprehensive lists.)

Flawless Operation, Safety Proof Design
Everlasting Dependability

SERVALL ANGLE CENTRIFUGE
(Superspeed)

Max. speed 14,000 r.p.m. or R.C.F. 25,000 x G
Max. capacity 8 x 50cc

SERVALL ANGLE CENTRIFUGES, Type SS-1 and SS-1A are today recognized as standard laboratory equipment for both research and routine work. Their savings in time and labor are already legend. They can be depended upon to give faithful service at those times when speed and volume count the most.
A Free Bulletin SC-71, will give you the complete report on the World's Best Made Centrifuge . . . the SERVALL Superspeed!

- Greater Speed —Easily Checked!
- Safety Self-Centering Device for Dynamical Balance
- Adapters Make Possible Use of 4 Different Tube Sizes!
- Separate Transformer — Added Usefulness
- Anodized Rotors for Corrosion-Resistance

Ivan Sorvall, inc.
210 - 5th Ave.
New York 10, New York

Now available . . .

Adenosine Triphosphate (ATP); Amygdalin; Amylase; Animal Lecithin; Ascorbic Acid Oxidase; Bacitracin; BAL; Biotin, cryst.; Caffeic Acil; Carotene, cryst.; Catalase; Cellulase Chlorogenic Acid; Chorionic Gonadotropin; Circulatory Hormone; Colchicine; Cytidylic Acid; Cytochrome C; Dehydroascorbic Acid; Diacetonamine; Dihydroxyacetone; Dihydroxyphenylalanine (DOPA); Dipyridyl; Edestin; Emulsin; Erythritol; N-Ethylpiperidine; Fibroin; Folic Acid; Galacturonic Acid; Gentisic Acid; Girard Reagents P and T; Gliadin; Glucose Pentaacetate; Glucuronic Acid; Glyceraldehyde; Glyceric Acid; Heparin; Hordenine; Hyaluronidase; Hydrindene; 2-Hydroxyadipaldehyde; Humulon; Indan; Isoascorbic Acid; Isopropylarterenol; Kojic Acid; Kynurenic Acid; Lanthionine; Lipase; Lysozyme; Lyxose; Malononitrile; Maltase; Melezitose; Mesobilirubinogen; Muscle Adenylic Acid; p-Nitrophenylphosphate; Nucleoprotein; Orcinol; Pancreatin; Pantothenyl Alcohol; Penicillinase; Peroxidase; Phenazine; Phenylpyruvic Acid; Phloridzin; Phosphorylase; Piperin; Porphyrindine; Protamines; Protoporphyrin; Pyridoxal; Pyridoxamine; Pyrocatechuic Acid; Pyruvic Aldehyde; Ribonuclease; Saccharic Acid; Salmine; Serine Phosphoric Acid; Spermidine; Spermine; Thioacetic Acid; Thiocytosine; Thyroxine; Trigonelline; Triphenyltetrazolium Chloride; Tripyridyl; Trypsinogen; Tyrosinase; Tyrothricin; Urease; Uricase; Uridine; Vitellin; Xanthosine.

Ask us for others!

DELTA CHEMICAL WORKS, INC.
23 West 60th St. New York 23, N.Y.
Telephone Plaza 7-6317

Just published . . .

ANNUAL REVIEW OF PLANT PHYSIOLOGY

volume 5 (1954)

"Each article is carefully documented, with long lists of references, publications of some 2800 scientists in these fields of research having been reviewed. Not only plant physiologists but all soil-plant scientists will find this volume, as well as those that have preceded it, a very useful reference work." *Soil Science,* October, 1953.

Editor:
D. I. Arnon

Associate Editor:
Leonard Machlis

Editorial Committee:
D. I. Arnon
J. Bonner
D. R. Goddard
M. W. Parker
C. A. Swanson
H. B. Tukey

Price: $7.00 postpaid

399 pages

Contents: Mechanism of Action of Micronutrient Elements in Enzyme Systems, *W. D. McElroy and A. Nason;* Nutrition by Foliar Application, *D. Boynton;* Mineral Nutrition of Phytoplankton, *B. H. Ketchum;* Soil Conditioners, *J. H. Quastel;* The Photosynthetic Function of Pigments Other than Chlorophyll, *L. R. Blinks;* Localization of Enzymes in the Cells of Higher Plants, *D. R. Goddard and H. A. Stafford;* The Physiology of Plant Tumors, *A. C. Braun;* Tropisms and Nastic Movements, *L. Brauner;* Dormancy in Woody Plants, *R. M. Samish;* Postharvest Physiology of Fruits and Vegetables, *W. T. Pentzer and P. H. Heinze;* Physiological Aspects of Fungus Diseases of Plants, *P. J. Allen;* The Role of Plant Physiology in Plant Geography, *H. L. Mason and P. R. Stout;* Photosynthesis, *R. Lumry, J. D. Spikes, and H. Eyring;* Occurrence, Formation, and Inactivation of Auxins, *S. A. Gordon.*

subject and author indexes

Also available: Volumes **1** (1950); **2** (1951); **3** (1952); **4** (1953). $7.00 postpaid

on sale by: **ANNUAL REVIEWS, INC., Stanford, California**

PERSONNEL PLACEMENT

YOUR ad here reaches over 32,000 scientists, including foremost scientists in leading educational institutions, industrial laboratories and research foundations in the U. S. and 76 foreign countries—at a very low cost.

CLASSIFIED: 18¢ per word, minimum charge $3.60. Use of Box Number counts as 10 additional words.

DISPLAY: Rates listed below—no charge for Box Number. Monthly invoices will be sent on a charge account basis —provided that satisfactory credit is established.

Single insertion	**$19.50 per inch**
7 times in 1 year	**17.50 per inch**
13 times in 1 year	**16.00 per inch**
26 times in 1 year	**14.00 per inch**
52 times in 1 year	**12.50 per inch**

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

POSITIONS WANTED

Anatomist, Ph.D., 3 years teaching experience. Gross Anatomy, Neuroanatomy, Histology, and Physiology. Desires teaching position. Box 180, SCIENCE. X

Bacteriologist—M.S. degree plus six years industrial experience, mainly as supervisor of sterilization and packaging of pharmaceuticals. Veteran, Sigma Xi. Will relocate. Box 183, SCIENCE. X

Biochemist: Sc.D.; Experienced in Enzymes, radiotracers, monomolecular layers, microchemical analyses, glass-blowing; publications. Desires research and/or teaching position east coast. Box 185, SCIENCE. 7/9

Biochemist; Ph.D.; since 1945, director development and distributor of plasma and liver fractions, pituitary factors for animal experimentation, purified enzymes. Medical Bureau (Burneice Larson, Director) Palmolive Building, Chicago. X

Pharmacist, B.S. Ph. M.S., desires position in pharmaceutical formulation or industry. Box 181, SCIENCE. X

Plant Pathologist, Ph.D., 34. Teaching experience in botany and research and extension experience in plant pathology. Desires teaching, extension or part time research in the East. Box 182, SCIENCE. X

Research Assistant, A.B. Biology, 6 years, including histological experience in the endocrinological and pharmacological fields. East or New England preferred. Box 179, SCIENCE. 7/2

Young Ph.D., experienced in teaching desires position in industrial or private research laboratory on West Coast. Major fields: enzymes, gastro-enterology, physiology, and vertebrate anatomy. Credentials and references upon request. Box 186, SCIENCE. X

POSITIONS OPEN

(a) **Assistant director** of research; duties: administrative with research; physician or Ph.D. (Major: Chemistry; Minor: Bacteriology or Pharmacology); large industrial company; East. (b) **Neurophysiologist,** experienced with recording action potentials from nervous system, advantageous if trained in neuro-anatomy; research department of chemical company; $6500–$7000 if newly graduated Ph.D.; Midwest. (c) **Technologist** qualified direct, 4-year collegiate program in medical technology; degree, preferably M.S.; considerable experience required; one of leading universities. (d) **Bacteriologist** to serve as chief technician, pathology department, one of leading clinics; staff of outstanding specialists, on faculty medical school. (e) **Several scientists,** Master's or Ph.D.'s, to head division, important hospital affiliated medical school; resort city, South. (f) **Instructors** in organic or physical chemistry; small college, Southwest. (g) **Ph.D.** in organic chemistry; research department, pharmaceutical company; Midwest. S7-1 Medical Bureau (Burneice Larson, Director) Palmolive Building, Chicago. X

POSITIONS OPEN

Biochemist. Ph.D. Hospital research laboratory affiliated with University of Cincinnati College of Medicine. Apply to Gastric Laboratory, Cincinnati General Hospital, Cincinnati 29, Ohio. 7/9

Research Assistant, B.S., M.S., Chemical or Biochemical background. A.E.C. enzyme project. Philadelphia. Box 184, SCIENCE. X

Plant Physiologist, Ph.D. and postdoctoral research experience, to work on problems of transpiration and soil moisture relations of crop plants. A 12-month full-time research position, $5500–$6600 per annum, depending on qualifications. Experience in agronomic work is desirable. Location in college town in Southeast. Write to Box 177, SCIENCE. 7/2, 9

SCIENTISTS—Salaried Positions, $6,000 to $35,000

This confidential service for outstanding Chemists, Engineers, Physicists, Metallurgists, etc. who desire a change of connection, will develop and conduct preliminary negotiations without risk to present position. Send name and address for details.
TOMSETT ASSOCIATES • 435 Frick Bldg., Pittsburgh 19, Pa.

LITERATURE CHEMIST

•

(Woman) — At least BS Degree, preferably in Chemistry, for technical literature surveys, translations (German and French primarily), abstracting.

Employee Relations Manager
Research & Development Department
Phillips Petroleum Company
Bartlesville, Oklahoma

AVOID DELAY . . . . *Cash in Advance payment*
MUST be enclosed with ALL classified ads.
See "Charges and Requirements"

The MARKET PLACE

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

CLASSIFIED: 25¢ per word, minimum charge $6.00. Use of Box Number counts as 10 additional words. Correct payment to SCIENCE must accompany ad.

DISPLAY: Rates listed below—no charge for Box Number. Monthly invoices will be sent on a charge account basis—provided that satisfactory credit is established.

Single insertion	$19.50 per inch
7 times in 1 year	17.50 per inch
13 times in 1 year	16.00 per inch
26 times in 1 year	14.00 per inch
52 times in 1 year	12.50 per inch

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

BOOKS AND MAGAZINES

WANTED TO PURCHASE . . .

SCIENTIFIC PERIODICALS and BOOKS

Sets and runs, foreign and domestic. Entire libraries and smaller collections wanted.

WALTER J. JOHNSON • 125 East 23rd St., New York 10, N. Y.

Your sets and files of scientific journals

are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. Write Dept. A3S, J. S. CANNER, INC. Boston 19, Massachusetts

SCIENTIFIC BOOKS and PERIODICALS WANTED

Complete libraries — Sets and runs — Single titles

Please send us your want list

STECHERT - HAFNER, INC. 31 East 10th St., New York 3

The World's Leading International Booksellers

PROFESSIONAL SERVICES

FOOD RESEARCH LABORATORIES, INC.

Founded 1922

Philip B. Hawk, Ph.D., President
Bernard L. Oser, Ph.D., Director

Research • Analyses • Consultation

Biological, Nutritional, Toxicological Studies for the Food, Drug and Allied Industries

48-14 33rd Street, Long Island City 1, N.Y.

• RESEARCH
• CONSULTATION
• ANALYSES

LOOKING FOR A PUBLISHER?

Write for Free Booklet SC telling how we can publish your book. All subjects considered. New authors welcome.

VANTAGE PRESS, Inc. • 120 W. 31 St., New York 1

In Calif.: 6356 Hollywood Blvd., Hollywood 28

WISCONSIN ALUMNI RESEARCH FOUNDATION

LABORATORY SERVICES

Project research and consultation in Biochemistry, Chemistry, Bacteriology and Entomology

Amino acid assays and biological protein evaluations • Vitamin and antibiotic assays • Chick feeding tests • Pharmacology including warm-blooded toxicity studies • Phenol coefficient determinations

Write for price schedule

WISCONSIN ALUMNI RESEARCH FOUNDATION

P. O. BOX 2059-V • MADISON 1, WISCONSIN

PROFESSIONAL SERVICES

For Indian Patents apply through Mr. S. M. Chaklanobis, B.L., Patent Attorney 2, Ajmal Khan Road, Calcutta 26, India.

SINCE 1870

Food Ingredient & New Drug Studies

DIGITALIS ASSAYS

LaWall & Harrisson

Bacteriologists
Chemists - Pharmacologists

Div. S, 1921 Walnut St., Philadelphia 3, Pa.

ANALYSES - CONSULTATION - RESEARCH

CONSULTATION RESEARCH

MICROBIOLOGY
PHARMACOLOGY
BIOCHEMISTRY
TOXICOLOGY
ANIMAL HISTOPATHOLOGY

SOUTH SHORE ANALYTICAL AND RESEARCH LABORATORY, Inc.

148 ISLIP AVE. ISLIP, N. Y.

SUPPLIES AND EQUIPMENT

STAINS

STARKMAN Biological Laboratory

• RARE
• COMMON

Price list on Request

• 461 Bloor St., W. Toronto, Canada

TACONIC FARMS

Germantown, N. Y.

Germantown 3535

• Swiss Mice
• Webster Strain

All AMINO ACIDS — natural, synthetic, unnatural, Rare Sugars, Biochemical Products, Reagents, New Pharmaceuticals in stock. Write or phone PLaza 7-8171 for complete price list.

BIOS LABORATORIES, INC. 17 West 60th Street, New York 23, N. Y.

RATS

Long-Evans (PAF)
Wistar (PAF)

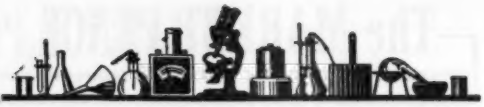
Bred for Research Work by Research Workers

PACIFIC ANIMAL FARMS

2457 Fletcher Dr., Los Angeles 39, Calif.

The MARKET PLACE

BOOKS • SERVICES • SUPPLIES • EQUIPMENT



SUPPLIES AND EQUIPMENT

SUPPLIES AND EQUIPMENT

HOLTZMAN RAT COMPANY

• • • •

• • • • producers of inbred albino rats suitable for Vitamin, Cancer, and Nutritional research.

• • • • offering continuity of quality and dependability of supply.

Rt. 4, Badger Lane Madison 5, Wisc. Phone 6-5573

Ask For GBI Price List

GBI research products, in convenient small packages—are offered as a special service to investigators. They will save you time, trouble and expense if you are engaged in research in these fields. →

BIOLOGICAL
MICROBIOLOGICAL
BACTERIOLOGICAL
BIOCHEMICAL
NUTRITIONAL

←Write for this useful reference book listing hundreds of items for research.

...GBI.. **General Biochemicals, Inc.**

72 LABORATORY PARK, CHAGRIN FALLS, OHIO

PURINES and other tagged compounds OF HIGH RADIOPURITY **C^{14}**

ISOTOPES SPECIALTIES CO. 3816-A San Fernando Rd. Glendale 4, Calif.

• **HYPOPHYSECTOMIZED RATS**

Shipped to all points via Air Express
For further information write

HORMONE ASSAY LABORATORIES, Inc. • 8159 South Spaulding Ave. Chicago 29, Ill.

• *Hamsters* • *Guinea Pigs* • *Rabbits* •

• *Rats* • *Mice*

RESEARCH

MANOR FARMS
Staatsburg, New York
Tel. Staatsburg 3278

Supplying every Research Need Since 1943

Cats • *Dogs*

LOOK AROUND... notice the increasing number of satisfied advertisers using small-space ads regularly in practically every issue of SCIENCE—*proof that these small ads get results!* If you have a product or service of interest to scientists, why not take advantage of this low-cost means of increasing your profits!

SCIENCE ON MICROCARDS

Following the requests of a number of libraries, the AAAS Board of Directors has decided to publish a microcard edition of SCIENCE. The 1953 issues are now available in this form. The space saving is considerable. 25 sets of 3″ x 5″ microcards take up approximately the same space as one set of the bound volumes of SCIENCE for 1953. The bother and expense of binding is completely eliminated.

The cost of the Microcard edition for 1953 has been set at $15.00 and it is anticipated that the Microcard edition of subsequent years will sell at the same price. Orders for the 1953 edition and standing orders may be placed with: AAAS, 1515 Massachusetts Avenue, NW, Washington 5, D. C.

Tracerlab
GEIGER-MUELLER TUBES...
the World's Best

Tracerlab's line of precision Geiger-Mueller tubes — produced in small, carefully processed lots — are the standard against which all others are compared. In addition to the universally used TGC-1 and TGC-2 Mica Window Tubes, such tubes as glass beta and gamma dipping tubes, proportional tubes, soft x-ray tubes, high efficiency and directional high efficiency gamma tubes for medical work, and industrial gamma tubes are available. Each tube is carefully tested to Tracerlab's rigid quality standards before it is assigned an individual warranty number and carefully packed in a tennis ball tin for shipment. All tubes — including several unique new models — are completely described and illustrated in *Catalog D,* copies of which will be sent on request.

Tracerlab® INC.
130 HIGH ST., BOSTON
2030 WRIGHT AVE., RICHMOND, CAL.

The first major improvement since the original Van Slyke design . . . . .

THOMAS–VAN SLYKE

MANOMETRIC BLOOD GAS APPARATUS

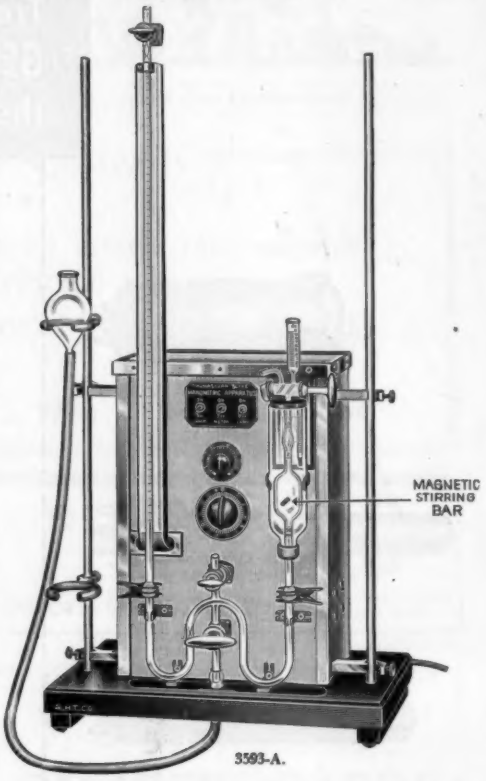
MAGNE-MATIC MODEL

(Patent Applied For)

- **Utilizes magnetic agitation instead of violent mechanical shaking, thereby reducing breakage of glassware**
- **Stationary, vertical extraction chamber permits rapid, reproducible adjustment of meniscus**
- **Ball-and-socket ground glass joints permit quick removal of glassware for cleaning, etc.**
- **Built-in timer provides for automatic reproducibility**
- **Corrosion-resistant housing is made of Formica and Stainless steel**

The contents of the chamber are agitated by a small Kel-F coated magnetic stirring bar, which is readily inserted and is floated by the rising mercury into the chamber where it is held by the field of the driving magnet and rotated in a vertical plane at a speed controlled by the rheostat. Its small volume has no significant effect upon the measured pressure.

This new method of agitation permits a *stationary chamber*, thereby reducing the costly breakage experienced because of the vibration due to the former method of violent shaking, and assures that the chamber is constantly vertical for rapid adjustment of meniscus, convenient addition of reagents, etc. The former troublesome rubber connection between the chamber and the manometer is replaced by a ball-and-socket ground glass joint, permitting quick removal of the chamber for cleaning, etc.



3593-A.

Other improvements have been incorporated, i.e., automatic timer in series with the motor switch, for reproducible periods of agitation; large handle on the lower stopcock for better flow control; housing of corrosion-resistant Formica and Stainless steel; acid-resistant finished hardwood base with trough for spilled mercury; spring tension clips on the stopcock plugs; unique illumination by means of a clear plastic column which carries the light and also serves as a support for the manometer; metal handle for the leveling bulb (not shown in illustration); all controls mounted on front panel; and rods at both sides for supporting accessory equipment as required.

3593-A. Thomas-Van Slyke Manometric Blood Gas Apparatus, Magne-Matic (Patent applied for), complete as shown in illustration, with improved type glassware, two magnetic stirring bars, 16 oz. Polyethylene wash bottle, clamps, Tygon tubing, etc., but without mercury or pipettes. For 115 volts, a.c. or d.c. .. **310.00**

Copy of Bulletin 120 sent upon request.

SYMBOL OF QUALITY
A.H.T.CO.
SPECIFICATION
LABORATORY APPARATUS

ARTHUR H. THOMAS COMPANY

Laboratory Apparatus and Reagents

WEST WASHINGTON SQUARE PHILADELPHIA 5, PA.

Teletype Services: Western Union WUX and Bell System PH-72